4th Annual Industrial Symbiosis Research Symposium

Information for Industrial Symbiosis:
Principles, Platforms, and Practices

June 16, 2007
University of Toronto, Canada

DALHOUSIE UNIVERSITY
Inspiring Minds

Yale School of Forestry
& Environmental Studies

Information for Industrial Symbiosis: Principles, Platforms, and Practices
4th Annual Industrial Symbiosis Research Symposium

Saturday, June 16, 2007
Room 303, Galbraith Building, 35 St. George Street
University of Toronto, Canada

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Introduction

Ray Cote, Dalhousie University - Co-chair
This meeting brings together a great community which has now come together at its fourth event. It is an opportunity to continue growing the good friendships that have already been formed. The symposium started at Yale in 2004 and continued in Stockholm in 2005 and Birmingham in 2006. Last year's chair and the incoming President of the ISIE, Roland Clift, has joined us today. An ad hoc organizing committee for this symposium actually met in Tianjin, China last fall and agreed that information management/information systems would be a good topic for the Toronto symposium.

This community of interest is not static and there are both new faces and older ones.
We hope to use this forum to facilitate the social networking that is so important for industrial symbiosis. With that in mind, we have designed the day to keep us talking together as much as possible. The registration covers box lunches as well as a group dinner this evening.
The meeting owes much to the invaluable work of Ramsey Wright of Dalhousie University, Julian Cleary of the University of Toronto, as well as Valerie Petersen and Weslynne Ashton of Yale University, in bringing the event to fruition.

Marian Chertow, Yale University - Co-chair
I would like to say a few words about the symposium and then lead the roundtable where we learn about industrial symbiosis (IS) developments in different parts of the world. We now have a record of all the IS symposia. The proceedings of the New Haven meeting were published in 2005. Today, we present the proceedings of the Birmingham meeting – edited by Rachel Lombardi of the University of Birmingham, UK, and Peter Laybourn of the National Industiral Symbiosis Programme, UK – which includes an appendix that summarizes the Stockholm meeting.

Gabriel Grant made a presentation on information technology for IS last year. There are many ways to organize information, so the organizers decided that we should make this topic the focus of our one day meeting prior to the ISIE conference. Today we will learn about models that are being developed for IS in the form of two presentations by Guillaume Massard of Switzerland and Tracy Casavant of Canada. We expect that these should be the source of great discussion. The symposium is not a conference, and the intent today is not to present a series of short papers but to generate discussion among the participants.

Several of you have been asked to provide short reports on the work that you are doing and the latest developments that are happening in your part of the world. In addition, we would also be interested in hearing about new ideas or projects that are being considered.

All attendees were invited to introduce themselves in under two minutes, highlighting who they are, where they are from around the world, and their interest or work in industrial symbiosis. The introductions indicated that most were from universities with others from industry, consulting, government and non-profit sectors.

Country and regional reports

United States

Peter Lowitt – In the US, there have been a number of new private sector initiatives, especially in the Gulf Coast area. It is encouraging to see our colleague from Dow here. The Kansas City Business Council for Sustainable Development (BCSD) has developed a large regional by-product exchange program. There is a public/non-profit two-state initiative in the Duluth and Lake Superior area led by the Center for Eco-Industrial Networking. I have recently been to planning conferences and attended poster sessions on EID/EIP and seen work from people that I've never heard of and have yet to meet. So there is a lot going on; but this pales to what is going on across the border in Canada where there is government support for EID projects. Devens has started taking off with a $1B investment in a bio-pharma plant by Bristol-Myers Squibb; a solar photo-voltaic manufacturing company; a construction waste recycling center; and a number of exchange opportunities. Seeing John here reminds me that we received an award from the Jessie B. Cox Charitable Fund to start a center modeled on the Eco-Efficiency Centre in Burnside Industrial Park in Nova Scotia.

Canada

Ray Cote – I am happy to report that there is much going on across Canada and it is expanding – largely due to Tracy Casavant and her active consultancy, Eco-Industrial Solutions Ltd. This differs from the situation I reported on in 2004 at Yale. Some governments are responding and encouraging projects; companies have picked up on the idea of using waste or by-products; and we now find projects across the country. Newfoundland is assessing eco-industrial opportunities including industrial symbiosis with a pulp and paper mill as the anchor in the Cornerbrook area of western side of the island. Nova Scotia's Department of Economic Development is leading an effort to build an industrial by-products map for the province with involvement from the Eco-Efficiency Centre. Graduate students in my industrial ecology course have been working on eco-industrial park projects in Nova Scotia, New Brunswick and Ontario in which symbioses are an important element. A study undertaken by the Eco-Efficiency Centre has also identified the potential for symbiosis with LNG re-gasification facilities, several of which have been proposed in eastern Canada. The "cold resource" that becomes available when LNG is regasified is viewed as having significant economic and energetic value.

Eco-Industrial Solutions is undertaking projects in Sudbury, Ontario; Regina, Saskatchewan; Hinton and Fort McMurray, Alberta; and in British Columbia. The Industrial Heartland area of Alberta, northeast of Edmonton, has identified by-product synergies as an important economic development strategy. There has been and continues to be interest in projects in Quebec, too, especially around Sorel. We expect to see more projects in the future as the potential of industrial symbiosis is increasingly realized by government and industry.

Asia

Anthony Chiu **–** I made short comments last year, now we have more data. Asian EIP projects are associated with government planning. I would place countries in two groups. In the first group are China, Japan, Australia, Taiwan and Korea. Korea has a three-phase, 15-year master plan which has been developed and adopted by government. This plan is currently being implemented by the Korean Cleaner Production Center in association with universities with $670M allocated to the development of six projects. In Taiwan, four projects are being planned, while three are already being implemented. The government has already given $185M to support these projects. There is increasing private interest in developing parks, but there is no single place or resource where private actors can access the necessary information. An EIP exhibition or resource center is needed.

Japan has 23 eco-towns, and is developing second generation software and policy. In Japan, they have also developed a resource recycling policy and legislation such as C&D End of Life policy that is similar to the EU, and have provided seed money to start a foundation for EOL processing, as well as private/non-profit societies. China has 16 EIP projects, there is a CP promotion law, and EIP scheme demonstration projects. The Circular Economy law includes legislation for eco-parks, eco-cities, and eco-provinces – but these apply only to official projects and a standard for eco-industrial parks has been developed. Unofficially, however, there are 123 EIP projects in China.

In the second group – Southeast Asia, the approach is more ad hoc. The Philippines are in Phase Four of a GTZ funded program, which has also received Swiss support, as well as technical support from Suren Erkman's group and one of Marian Chertow's students. In Thailand, the government's industrial development policy during the period 1997–2005 has not given much support to environmental issues although the Industrial Estates Authority has expressed interest in EIPs and IS. Other countries are still in the Cleaner Production phase.

Portugal

Ines Costa / Paulo Ferrao **–** There has been ongoing collaboration with waste institutions to manage waste information in the country. Their task is focused on the management of information and creating a dynamic database to formalize and generate data, provide an interface for waste generators, and become a depository of information that can be used for IS research.

There are two major projects: (1) development of an organized waste market, which involves legal issues in developing the national waste policy, together with a research group that works with the government to implement the best approach; (2) Chamusca EIP development in a depressed region where there are existing strengths in the waste management infrastructure with landfills and waste sorting facilities. With regard to the latter project, there are two components: (1) to create a vision for EID in the region, and, second, building on the 40 proposals for IS links; (2) simultaneously to advance a database of IS connections to identify 'kernels' in the country.

In the last five years, many End-of-life processing companies have formed to handle oil, tires, and waste electronic equipment (WEE). Recommendations for developing these companies have been based on the work of our graduate students, some of whom have now been employed by

these firms. This is connected to Extended Producer Responsibility (EPR) in which each producer has to create a mechanism or company to satisfy quotas for recycling, reuse, and conservation. These companies are fed by taxes when new products are brought to market, but the producers must pay all expenses to cover recycling/collection by their subsidiaries. WEE processing covers at least 10 product classes, including watches and HVAC systems. Our students are modeling technology on how the country shoykd organize to recover the products and materials and what would be the respective costs? We have developed our own 'IE diplomacy' between government and companies by working at their intersection, and have developed the credibility to do these studies.

Norway

Edgar Hertwich – I have no great report on a national scale, just from our group at NTNU. There is an attempt to build an EIP around a refinery so we are examining refinery-based opportunities, such as chemicals, processes, and related activities, and we are covering new ground in methodology. Norway is a mature economy and opportunities to locate new facilities are limited, which is a fundamental problem. Therefore, we are looking more in the direction of ports and engineering waste exchanges across larger geographic scales, because co-location does not work well for this situation.

Spain

Gemma Cervantes – In the Mediterranean, the Eco-sim project promoting IS in the MESVAL Area has been supported by the European Union. There are 14 small sub-projects. The MESVAL region includes Italy (Tuscany), Greece, Spain (Catalonia), and five industrial sectors (textiles, surface treatment, leather, olive oil, cosmetics). We identified possible exchanges that could be made, and chose six exchanges for further investigation, based on valuation from different methods, including best technology and sustainability indicators (economic, environmental, social). The best valuation was made from a sustainability point of view. We have created a Masters Program in Industrial Ecology, which was started in Italy and Catalonia Spain, with two to three more universities expected to join and offer the degree next year.

Kalundborg, Denmark

Jorgen Christensen – Kalundborg is a slow, developing project that was started in the late 1960s. In 2006-2007, we added two new projects, making 24 links in total over the history of the system. Of the 24, three have been terminated. One of the new projects involves sending salty cooling water from E2 to the refinery. There are many other projects under consideration such as a bio-ethanol plant that could have many synergies involving several partners. The decision for this project is up to investors now, and if oil prices go up or if government lowers taxes, it will be cost effective to go forward with the investment.

We are conscious of organizational and personnel changes, we have to keep up with new people – bring them into the discussion. The board now has a majority of newcomers so we need to do things to increase interest in IS. The Symbiosis Institute continues to be very active with several events, visits, and conferences in the past three to five years. Jorgen has been invited to speak at many of these activities respectively. Visitors to the institute fall into four groups – students from universities, individuals (scientists, journalists), professionals (those with serious positive interest) and Asian representatives (those involved in China's circular economy, as well as those

from Japan which seems to have industrial tourism). We have also been giving presentations in Europe. I recently visited a new EIP in Norway, in Stavanger Energy Park, an initiative which was started in 2003 by companies in the area. An old area with an oil refinery was torn down. There was extensive site cleaning and the companies generated the idea of an EIP based on Kalundborg. However, the way they will implement it will be in a different direction as the focus will be on energy and natural gas utilization, hoping to attract companies that will support each other with some symbiosis.

Australia

Albena Bossilkov – Rene Van Berkel left Curtin University in 2006, and the group has subsequently been without a leader . The development of IS or regional synergies as they are known in Australia has progressed in Kwinana and Gladstone in Western Australia. In Kwinana, in addition to the 47 existing links, 89 potential synergies were identified. Fifteen of these potential linkages are being further investigated and ten of these have a good chance of being implemented. We are developing a parallel project to develop tools and technology to assess, identify and evaluate regional synergies. Some new industrial areas have shown interest: Rustenberg, South Africa around platinum operations, and Geelong in Victoria, Australia. There has also been interest expressed in another project in Southern Australia, where there is a BP joint venture to build an integrated coal-gas plant– we have been hired to research potential synergies, so that they could be incorporated at the design stage. Our focus will be on the economic feasibility of utilizing inorganic residues, limestone, sands, fly ash, slag, and to identify nearby infrastructure and other applications.

Mexico

*Gemma Cervantes***–** Gemma is currently working in Mexico and indicated that local government in Mexico City is interested in introducing IS in one of its industrial estates.

China

Shi Han **–** Development is occurring at several levels relating to policy formulation for the Circular Economy promotion law. It received a lot of expert involvement from universities and others and we received World Bank assistance with learning from different countries. The policy was submitted to the National People's Congress for approval and we are expecting approval early next year. The SEPA's EIP policy has grown from 16 projects to encompass 26 projects and has had to formulate national EIP standards beyond the demonstration EIP to include mixed industry, single industry, recycling industry, economic, environmental and social aspects. SEPA (State Environmental Protection Administration) now wants to review the performance of the 26 national demonstration projects, and nominate 4 more. Tianjin/TEDA may be first – with much of the focus on the symbiosis approach. Another approach is being advocated by the most powerful ministry, NDRC, such that the planning commission is to develop circular economy demonstration programs, at company, industrial park, and at region/city/province levels, so that energy conservation programs are highlighted. Improved design from the beginning is a strategy that China can afford to do. Currently, it seems like almost every professor in China is consulting on a few projects on the circular economy, whether IS can play central role, or on other concepts such as technology innovation.

UK's NISP report was sent as an executive summary report by ***Peter Laybourn***.

Commentary

Abhishek Agarwal added that, in his presentation at ISIE, he will give results on some work that he did with NISP where he looked at three aspects: national policy, the effectiveness of the regional context, and industry perspective on the quality of the program. He found that the regional context is more appropriate compared to other levels such as national and sub-national and will discuss that.

Jennifer Howard-Grenville's presentation will highlight some of her work where her team has been looking at the most established region that predated NISP. In this case, they analyzed the synergies that have been completed and interviewed firm managers for their perspectives. They found that many of the firms came to synergies through pre-dated relationships, such as those through other business organizations, and in general don't seek out industrial symbioses anew. There is a sense of which synergies grow from existing tensions related to the need to find creative solutions. They are examining the theoretical frame needed to bring to the problem of unpacking how to create new synergies around embedded organizations.

Roland Clift raised several comments from a one day workshop that they ran last week. There were presentations from NISP, as well as from other organizations such as ENVIROWISE, which is a government/private group encouraging companies to use clean technology. There is a possible tension between these approaches, and the relationship between NISP and Envirowise will be something to watch. He pointed out that the scope of industrial symbiosis is different for industrializing vs. mature or dematerializing economies. The sectors left in the UK and Norway are electronics and automobiles, and there is now a strong emphasis on take-back directives. In other sectors IS could be limited; dominant sectors are construction, food and retail. Quantities of materials reported by NISP are dominated by construction; more interesting is what's going on in food and retailing, where there is a lot of pressure to reduce carbon footprint. In his view, it is a misguided policy to put carbon labels on consumer products. What you do with co-products will become more important if carbon labels can have positive effect by having them as drivers for carbon emissions through sensible use of co-products. Clift suggested that waste legislation in the EU is in turmoil, but that NISP is well-connected to the agency that polices waste legislation and related environmental agencies. He expects funding will not be an issue, unless there is major upheaval, as NISP is being recognized as a positive force.

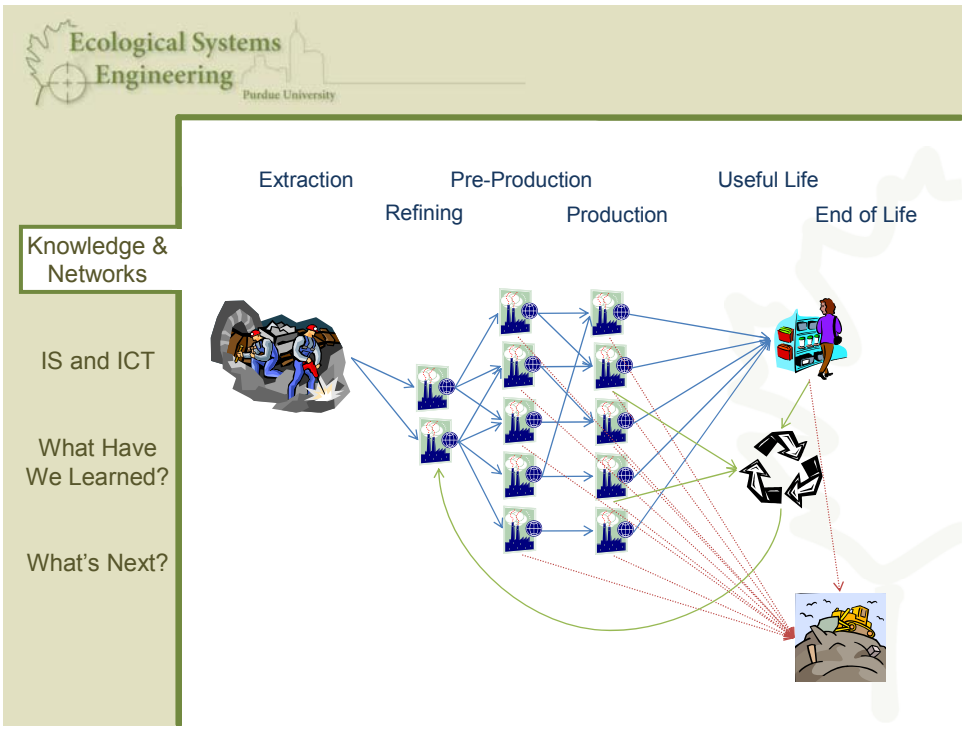
Reid Lifset offered comments as ***JIE*** editor on the research that has been submitted for publication – there is growth in more sophisticated research. In his view, industrial symbiosis is really getting somewhere.

Anthony Chiu noted that program budgets have been an issue in Asia. In Taiwan, there was a $185M government subsidy and private investment is $1B for eco-industrial park development. Promoters of the concept believe that putting up an exhibition center can help sustain projects and be a good model for other regions.

Marian Chertow commented briefly on the situation in ***Puerto Rico***. Weslynne Ashton has been documenting the death of an industrial ecosystem and may have valuable lessons. She will give a related presentation on this at ISIE.

Presentations

1. Knowledge Infrastructure for Industrial Symbiosis – Gabriel Grant



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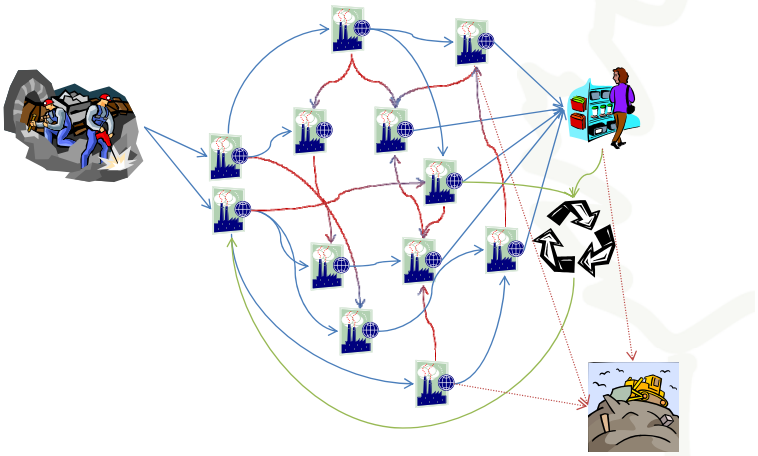
What Have We Learned?

What's Next?



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What Have We Learned?

What's Next?

IS economic feasibility occurs when:

Savings from by-product feedstock compared with virgin material $\geq$ Transaction costs incurred adopting the IS practice in place of traditional practice

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What Have We Learned?

What's Next?

IS economic feasibility occurs when:

Savings		Transaction costs
• Environmental Regulation • Resource Scarcity	≥	• Opportunity Discovery • Assessment •Legal Costs for Regulatory Compliance • Monitoring, Quality Control • Business Contracting

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What Have We Learned?

What's Next?

Social Capital, which includes trust, reduces transaction costs

*"The central premise of social capital is that **social networks have value**. Social capital refers to the collective value of all 'social networks' and the inclinations that arise from these networks to do things for each other. The term social capital emphasizes not just warm and cuddly feelings, but a wide variety of quite specific benefits that flow from the **trust, reciprocity, information, and cooperation** associated with social networks. Social capital creates value for the people who are connected and—at least sometimes—for bystanders as well." (Putnam 2000).*

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What Have We Learned?

What's Next?

Social Capital, which includes trust, reduces transaction costs

≥

- Opportunity Discovery
- Assessment
- Legal Costs for Regulatory Compliance
- Monitoring, Quality Control
- Business Contracting

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What Have We Learned?

What's Next?

Observations:

1. Kalundborg exhibits extremely high social capital, creating a *"short mental distance between firms"* which reduces the cost of opportunity discovery and other transaction costs (Ehrenfeld and Gertler 1997)

   "Today the basis of the Symbiosis co-operation of Kalundborg is openness, communication and mutual trust between the partners. The Kalundborg companies are located in a small community that has helped establish fine conditions for open and intimate working relations." (Kalundborg Centre for Industrial Symbiosis)

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What Have We Learned?

What's Next?

Why don't we just create more social capital?

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What Have We Learned?

What's Next?

Observations:

2. Despite the evolutionary self-organizing nature of Kalundborg, political and academic initiatives have focused toward planning models and away from the spontaneous collaborative mechanisms behind Kalundborg (Desrochers 2004)

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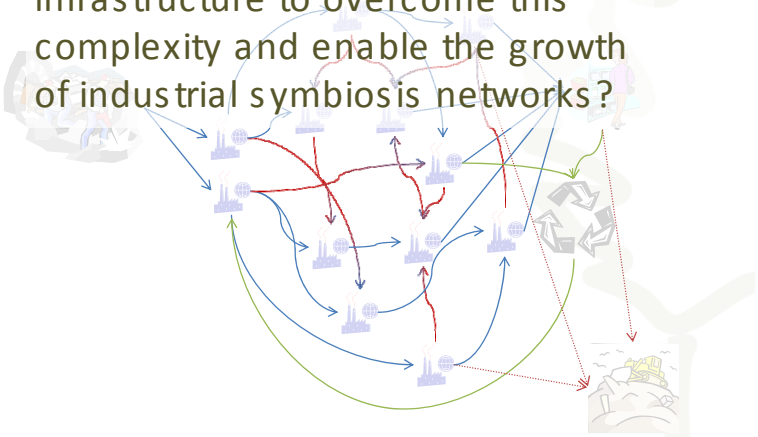
What Have We Learned?

What's Next?

Can we employ new **knowledge** infrastructure to overcome this complexity and enable the growth of industrial symbiosis networks?



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What Have We Learned?

What's Next?

What is knowledge? I thought this talk was going to be about information?

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What Have We Learned?

What's Next?

Differing Views on Economic Structure

	Transaction-Cost Economic Theory	Knowledge-Based Economic Theory
Role of the Firm	• Eliminate or Minimize Transaction Costs	• Knowledge Integration and Application

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What Have We Learned?

What's Next?

What is knowledge? I thought this talk was going to be about information?

Knowledge
= SUM(Tacit Knowledge,Explicit Knowledge,…)

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What Have We Learned?

What's Next?

Explicit Knowledge (Information)	Tacit Knowledge (Know-How)
100110 101001	
•Facts	•Trust
•Measurements	•Understanding

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What Have We Learned?

What's Next?

Explicit Knowledge (Information)	Tacit Knowledge (Know-How)
100110 101001	
•Easily communicated	•Difficult to communicate
•Codified	•Revealed through application
•Centralized	•Place based
•Aggregated using tools such as statistics	•Socially and culturally contextual

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What Have We Learned?

What's Next?

Why's this important?

Understanding the differences between tacit and explicit knowledge influences our strategies to transmit and integrate knowledge - aka the way we communicate and coordinate with one another

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What Have We Learned?

What's Next?

What makes this an economic theory?

From a knowledge-based perspective firms are created because they, compared to markets, provide a more effective environment for transferring knowledge

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What Have We Learned?

What's Next?

The Market's Ability to Transfer Knowledge is Restricted by:

1. "the immobility of tacit knowledge"
2. "the risk of expropriation of explicit knowledge by the potential buyer"

(Grant 1996)

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What Have We Learned?

What's Next?

Firms create environments and incentives that foster the personal communication required to convey tacit knowledge and allow explicit knowledge to be shared between people on the same team without risk of expropriation. Thus firms exist to provide a more effective organization than markets for individuals to integrate and apply knowledge (Grant 1996).

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What Have We Learned?

What's Next?

Management Perspectives

	Transaction-Cost Economic Theory
Primary Challenge:	• Opportunism
Structural Response:	• Hierarchical Coordination

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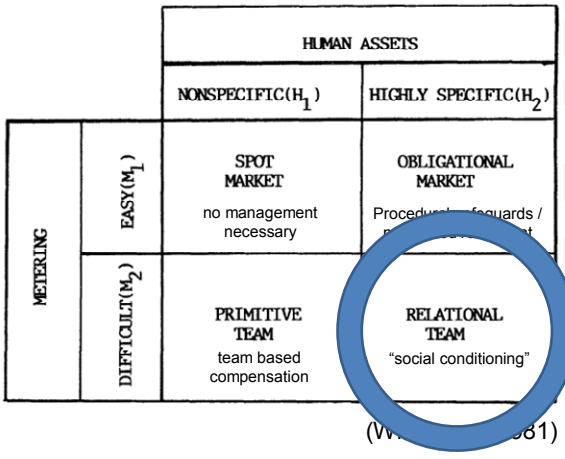
What Have We Learned?

What's Next?

Management Perspectives



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What Have We Learned?

What's Next?

Management Perspectives

Relational teams are very difficult to develop, and it is uncertain how widespread or sustainable they are. It is argued that some of the Japanese corporations are organized in this way (for a discussion, see Lifson 1979), but the interpretation of this is subject to dispute. Certain utopian societies are organized as relational teams, but these have experienced severe continuity problems as the initial membership, which often was highly committed, retired or expired (see Kanter 1972; Manuel and Manuel 1979).

(Williamson 1981)

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What Have We Learned?

What's Next?

Explicit Knowledge Can Travel Through Management

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What Have We Learned?

What's Next?

Explicit Knowledge Can Travel Through Management

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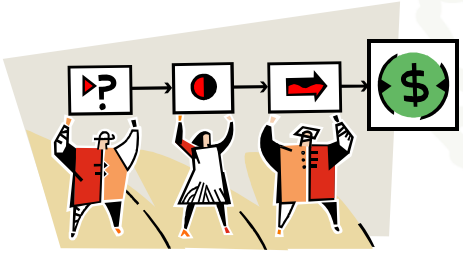
What Have We Learned?

What's Next?

Tacit Knowledge Can Travel Between Users



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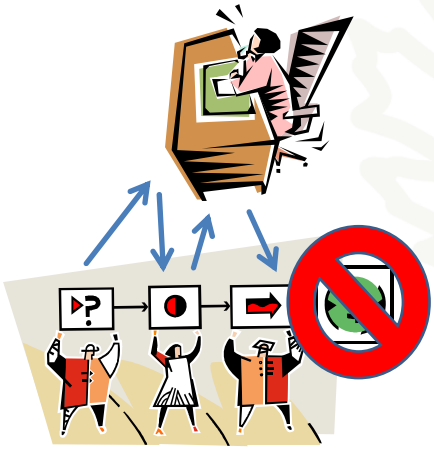
What Have We Learned?

What's Next?

But, Tacit Knowledge Can NOT Travel Through Management



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What Have We Learned?

What's Next?

Management Perspectives

"Once firms are viewed as institutions for integrating knowledge, a major part of which is tacit and can be exercised only by those who possess it, then the hierarchical coordination fails." (Grant 1996).

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What Have We Learned?

What's Next?

Management Perspectives

	Transaction-Cost Economic Theory	Knowledge-Based Economic Theory
Primary Challenge:	• Opportunism	• Integration/Coordination
Structural Response:	• Hierarchical Coordination	• Distributed, Decentralized Decision Making

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What Have We Learned?

What's Next?

What would a knowledge-based firm look like?

"Aoki (Aoki 1990) observes that one of the differences between U.S. and Japanese corporations is that, while the hierarchies of Western firms combine the roles of cooperation and coordination, Japanese hierarchies exist primarily to provide the incentive structures to support cooperation, but coordination occurs outside the formal hierarchy."(Grant 1996)

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What Have We Learned?

What's Next?

What would a knowledge-based firm look like?

	Transaction Cost Economy	Knowledge-Based Economy
Role of the Firm	Minimize Transaction Costs	Maximize Ability to Create, Store, and Apply Knowledge
Production	Centralized Economies of Scale	Distributed Economies of Scope
Decision Making	Top-Down Delegation	Participative/Decentralized
Coordination Between Firms	Independent/ Connected by Markets	Integrated/Collaborative/ Networked
Driving Force	Cost Minimization	Learning and Innovation
Primary Challenge	Opportunism/Incompatibility of Individual Goals	Coordination/Integration

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What Have We Learned?

What's Next?

If knowledge is integrated and applied within firms, where is it created and stored?

1. Networks offer a competitive institution for creating and accessing knowledge (Dyer and Nobeoka 2000)
2. Technology transfer and often innovation occur outside any single firms' borders (Powell, Koput et al. 1996; Ahuja 2000)
3. Large numbers of week ties in social networks strongly influence opportunity identification within entrepreneurship and innovation (Granovetter 1973; Hills, Lumpkin et al. 1997)
4. Membership in a business network is an important determining factor in entrepreneurial success (Davidsson and Honig 2003)

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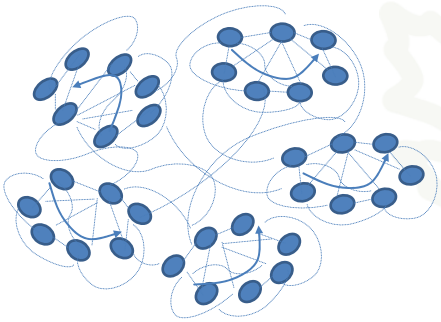
What Have We Learned?

What's Next?

Beyond Firms: Knowledge Sharing Networks aka Communities of Practice



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What Have We Learned?

What's Next?

Key Challenges and Resolutions from the Toyota Group case study

1. Motivate Participation
2. Prevent Parasitic or Free-Rider Participation
3. Minimize Knowledge Costs

(Dyer and Nobeoka 2000)

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What Have We Learned?

What's Next?

Key Challenges and Resolutions from the Toyota Group case study

1. The Supplier Association
   i. exchange information
   ii. development and training
   iii. socializing events

2. Toyota's Operations Management Consulting Division
   i. free consulting
   ii. detached from Toyota's purchasing

3. Voluntary Small Group Learning Teams
   i. plant tours – cooperative improvement
   ii. conferences – best practices showcase

4. Interfirm Employee Job Rotations

(Dyer and Nobeoka 2000)

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What Have We Learned?

What's Next?

Cultural Anomaly or Utopian Society?

Relational teams are very difficult to develop, and it is uncertain how widespread or sustainable they are. It is argued that some of the Japanese corporations [illegible] (see Lifson 1979), but the interpretation of this is subject to dispute. Certain utopian societies can be regarded as relational teams, but these have experienced severe continuity problems as the initial membership, which often was highly committed, retired or expired (see Kanter 1972; Manuel and Manuel 1979).

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What Have We Learned?

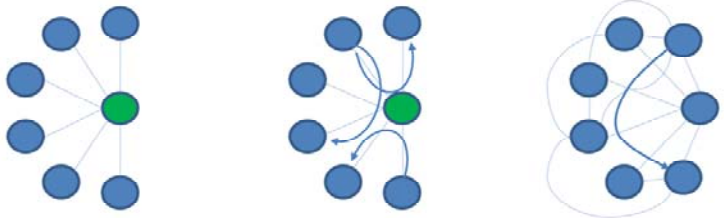
What's Next?

Cultural Anomaly or Utopian Society?

Relational teams are very difficult to develop, and it is uncertain how widespread or sustainable they are. It is argued that some of the Japanese corporations [illegible] (see Lifson 1979), but the interpretation of this is subject to dispute. Certain utopian societies are depicted as relational teams, but these have experienced severe continuity problems as the initial membership, which often was highly committed, retired or expired (see Kanter 1972; Manuel and Manuel 1979).

1989 – Bluegrass Automotive Manufacturers Association
1992 – Toyota Supplier Support Center
1994 – Plant Development Activity Core Groups

Initiation Phase Ineffective Knowledge-Sharing Network	Developmental Phase	Mature Phase Effective Knowledge-Sharing Network



Dimensions	Initiation Characteristics	Mature Characteristics
Structure:	•One large network with core firm as hub	• Large network plus multiple "nested networks"
	• Bilateral relationships with core firm	• Multi-lateral relationships
	• Weak ties among most members	• Strong/embedded ties in nested networks and deemphasized core firm
	• Numerous structural holes	• Few structural holes
Knowledge Transfer:	• Explicit	• Explicit and tacit
Motivation:	• Demonstrate commitment to core firm	• Learn faster than competitors (benefits of participation far outweigh isolation); reciprocity

adapted from (Dyer and Nobeoka

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What Have We Learned?

What's Next?

Network Benefits

> We've benefitted greatly by participating in the [PDA core] group. It is now very natural for us to share what we know with the other suppliers in our group. We know each other well and are committed to helping each other . . . I don't know that I could have imagined this sort of activity five years ago. We just didn't interact with other suppliers.

(Dyer and Nobeoka 2000)

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What Have We Learned?

What's Next?

Network Benefits

1. Innovation and Opportunity Identification
2. Technology Transfer, Collaboration

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What Have We Learned?

What's Next?

How can Information and Communications Technology (ICT) support a knowledge sharing network?

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What Have We Learned?

What's Next?

ICT and Knowledge Sharing Networks

Expert Systems vs. Online Communities

The Eureka Project

(Brown and Duguid 2000)

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What Have We Learned?

What's Next?

"Executives who want to identify and foster best practices must ***pay very close attention to the practices as they occur in reality*** *rather than as they are represented in documentation or process designs. Otherwise, they will miss the* ***tacit knowledge produced in improvisation****, shared through story-telling, and embedded in the communities that form around those activities…* ***Armed with a sense of what really happens on the ground, it's possible to design processes that prompt improvisation rather than ones that are blindly prescriptive****."(Brown and Duguid 2000)*

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What Have We Learned?

What's Next?

ICT and Knowledge Sharing Networks

Expert Systems vs. Online Communities

Successful ICT knowledge management systems focus on the human-human communication and overcome the Western tendency to merely 'put it in a database' (Skyrme 1998)

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What Have We Learned?

What's Next?

ICT and Knowledge Sharing Networks

ICT systems are now designed with the specific objectives of fostering community social capital and trust (Abdul-Rahman and Hailes 2000; Kasper-Fuehrer and Ashkanasy 2001; Huysman and Wulf 2006)

eBay

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What Have We Learned?

What's Next?

ICT and Knowledge Sharing Networks

"Computer-supported solutions are developing for working through trusted interpersonal relationships to identify, locate, and receive information within and between communities and organizations" (Wellman 2001).

Linked-In

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What Have We Learned?

What's Next?

ICT and Knowledge Sharing Networks

Usability	Sociability
Human-Computer Interaction	Human-Human Interaction

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What Have We Learned?

What's Next?

Implications for Industrial Symbiosis -looking back

If industrial symbiosis relies on tacit knowledge and tacit knowledge can not be transmitted through a hierarchy, knowledge-based theory predicts:

1. The concepts of social capital and trust as key precursors for industrial symbiosis development (Ehrenfeld and Gertler 1997; Gibbs 2003)
2. Failure of industrial symbiosis central planning analogous to that of a centrally planned economy (Desrochers 2004)
3. The importance of a network model (Berends 2001; Mirata 2004; Mirata and Emtairah 2005; Beers, Corder et al. 2007)
4. The ability to nurture or accelerate symbiosis where it has already been found to exist (Chertow 2007)

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What Have We Learned?

What's Next?

Implications for Industrial Symbiosis -ways forward

1. Knowledge-Based management provides a road map for the evolution and purposeful construction of inter-firm knowledge networks that support innovation and opportunity discovery between firms
2. ICT research in usability AND sociability provides both on-line and off-line community support
3. Through the development of ICT systems in support of an industrial symbiosis community of practice , we can leverage the information revolution to bridge the industrial revolution into an age of industrial symbiosis

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What Have We Learned?

What's Next?

Where is this happening? Can we see this now, please!

IS and ICT Case Studies

- KBDSS
- DIET
- IME
- DIME
- MatchMaker!
- IEPT
- WasteX
- IEDP
- RUES
- IUWAWM
- Presteo
- CRISP
- MapIt!
- Eco-Flow
- Kwinana

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Knowledge Based Decision Support System

Proponents: C. A. Boyle from the University of Auckland and B. Baetz from McMaster University

Application: Four plants within the Point Lisas Industrial Estate in Trinidad

Key Functionalities: Waste Treatment and Re-use Opportunity Identification

Status: Completed

Availability: None

IS and ICT Case Studies

- KBDSS
- DIET
- IME
- DIME
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- Kwinana

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Designing Industrial Ecosystems Toolkit

Proponents: Developed by Industrial Economics Inc. in partnership with Clark University for the US EPA's Office of Policy, Planning and Evaluation, Urban and Economic Development Division

Application: Burlington, Vermont Eco-Industrial Park

Key Functionalities: Text based input-output matching, ind. park job, env., and $ optimization, barrier recording capability to filter matches

Status: Cancelled

Availability: Public, Requires Office 95 and Access Skills

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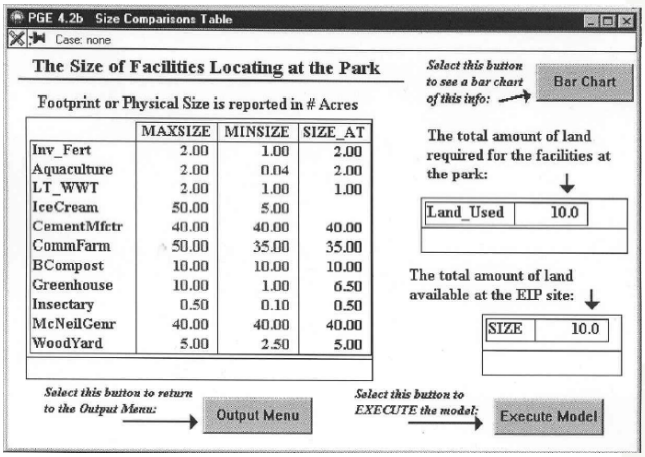
Designing Industrial Ecosystems Toolkit



Source: US EPA and Industrial Economics Inc.

IS and ICT Case Studies
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Presteo
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Industrial Materials Exchange Tool

Proponents: Bechtel (now Nexant) corporation in cooperation with the Brownsville Economic Development Council and the City of Brownsville, TX

Application: Brownsville, TX

Key Functionalities: Input-output matching

Status: Cancelled

Availability: None

IS and ICT Case Studies

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Dynamic Industrial Materials Exchange Tool

Proponents: Bechtel and Idaho National Engineering and Environmental Laboratory

Application: Ethanol and natural gas in the greater Yellowstone-Teton region

Key Functionalities: Incorporated system dynamics into Bechtel's IME model to evaluate changing and interconnected variables such as energy costs

Status: Completed

Availability: None

IS and ICT Case Studies

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MatchMaker!

Proponents: M.S. students Jason Brown, Daniel Gross, and Lance Wiggs at Yale

Application: Course project

Key Functionalities: Incorporated standardized industrial classification (SIC) codes, began development on a materials taxonomy, and connected an SIC based phone directory into Bechtel's IME model to search for possible participants

Status: Completed

Availability: None

IS and ICT Case Studies

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Industrial Ecology Planning Tool

Proponents: Carolyn Nobel, M.S. thesis Univ. of Texas

Application: Bayport Industrial Complex in Pasadena, TX

Key Functionalities: GIS based water resource optimization

Status: Completed

Availability: Source code included in thesis

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Industrial Ecology Planning Tool

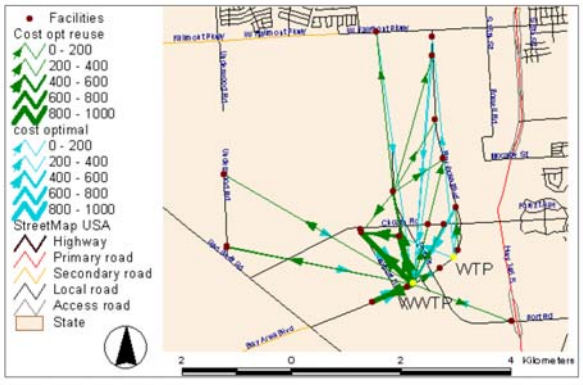

Figure 20: Cost-optimal pathways for the large network graduated by flow rate (1000gpd).

Source: Carolyn Nobel, Thesis, Univ. of Texas

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WasteX

Proponents: University of West Indies, Canadian International Development Agency Environmental Action Programme, and Premier Waste Management

Application: Jamaica

Key Functionalities: Online waste exchange

Status: Cancelled

Availability: None

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WasteX
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WasteX

Source: www.wastex.org.jm care of The Way Back Machine

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Industrial Ecosystem Development Project

Proponents: Triangle J Council of Governments, US EPA, North Carolina State Energy Office

Application: North Carolina Triangle J Region

Key Functionalities: Input-output database connected to GIS, beginning taxonomy for SIC based resources

Status: Cancelled

Availability: None

IS and ICT Case Studies

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Residual Utilization Expert System

Proponents: The University Transportation Center for Alabama, the Alabama Department of Transportation, and Fonseca, Richards, Williamson, and Moynihan at the Univ. of Alabama

Application: Birmingham and Mobile, AL

Key Functionalities: Rules based technical feasibility evaluation for residual re-use in highway materials applications

Status: Completed

Availability: Original project sponsors

IS and ICT Case Studies

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Institute of Eco-Industrial Analysis Waste Manager

Proponents: Institute of Eco-Industrial Analysis

Application: Tested on Heidelberg-Pfaffengrund industrial site, for sale in Europe

Key Functionalities: Waste reporting, integration of European waste code taxonomy, both firm-based and collective optimization functions, price benchmarking, identifies opportunities for collaboration and optimized logistics incorporating GIS routing

Status: Operational

Availability: Online purchasable and demo available

IS and ICT Case Studies

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Presteo
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Presteo

Proponents: Republic of Canton in Geneva, Institute for Communication and Analysis of Science and Technology, The University of Lausanne Industrial Ecology Group, Systemes Durables, State of Geneva ECOSITE Committee, Center for Interdisciplinary Research and Development at Troyes Univ. of Technology, French Research Ministry, United Nations Agenda 21, EDF

Application: Geneva region

Key Functionalities: GIS based input-output matching

Status: Operational

Availability: Facilitator operated amongst participants

IS and ICT Case Studies

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- CRISP
- MapIt!
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- Kwinana

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Core Resource for Industrial Symbiosis Practitioners

Proponents: National Industrial Symbiosis Programme (NISP)

Application: UK

Key Functionalities: Primarily designed as a project management tool to track synergy progression and success amongst a network of NISP practitioners

Status: Operational

Availability: Within the NISP practitioner network

IS and ICT Case Studies

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- Eco-Flow
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MapIt!

Proponents: Eco-Industrial Solutions and City of Sudbury

Application: Greater Sudbury, Ontario

Key Functionalities: GIS based opportunity identification and assessment

Status: Under development

Availability: coming soon to existing and future industrial firms in the greater Sudbury, Ontario area

IS and ICT Case Studies

- KBDSS
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- CRISP
- MapIt!
- Eco-Flow
- Kwinana

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Eco-Flow

Proponents: Ohio State University Center for Resilience and the US EPA

Application: Columbus, OH region

Key Functionalities: Not yet known

Status: Planned

Availability: N/A

IS and ICT Case Studies

- KBDSS
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- IEPT
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- IUWAWM
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- MapIt!
- Eco-Flow
- Kwinana

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Kwinana

Proponents: CSRP

Application: Kwinana Industrial Region

Key Functionalities: None

Status: Planned

Availability: N/A

IS and ICT Case Studies

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MatchMaker!
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IEDP
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CRISP
MapIt!
Eco-Flow
Kwinana

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Nova Scotia

Proponents: Ray Cote, Dalhousie University Eco Efficiency Centre

Application: King's County, Nova Scotia

Key Functionalities: GIS based resource mapping

Status: Planned

Availability: N/A

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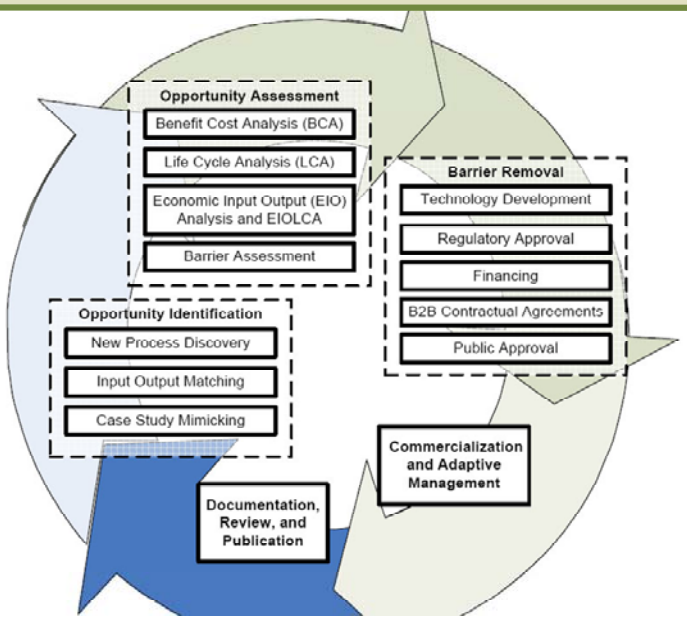
Knowledge & Networks

IS and ICT

What Have We Learned?

What's Next?



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IS and ICT

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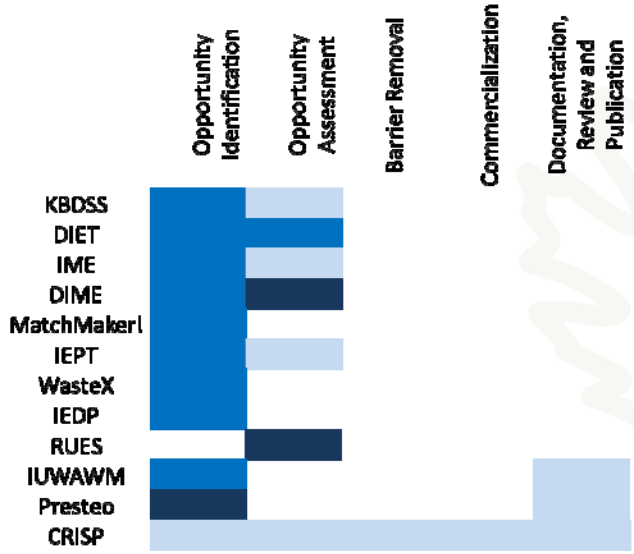

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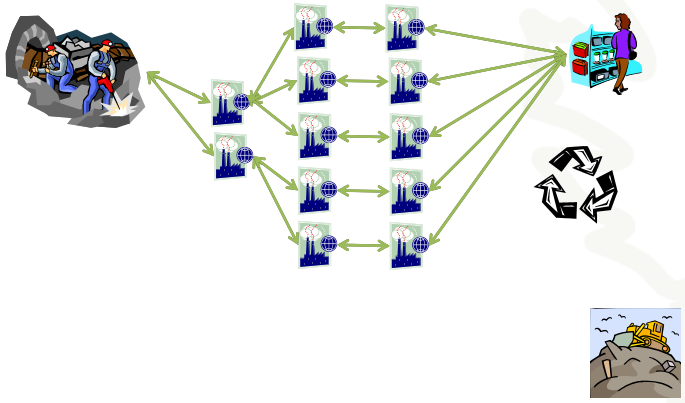
Existing Knowledge Infrastructure

Knowledge & Networks

IS and ICT

What Have We Learned?

What's Next?



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What Have We Learned?

What's Next?

… lies within Market Sectors

Agriculture

Manufacturing

Medicine

Water

Energy

Existing Knowledge Infrastructure

- Markets
- Supply Chains
- Industry Associations
- Academic Disciplines

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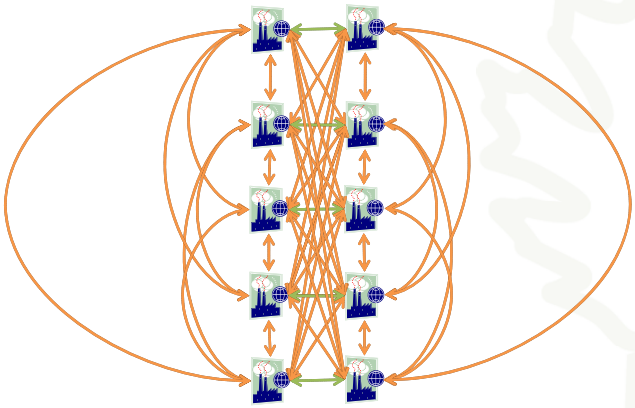
What Have We Learned?

What's Next?

Required Knowledge Infrastructure



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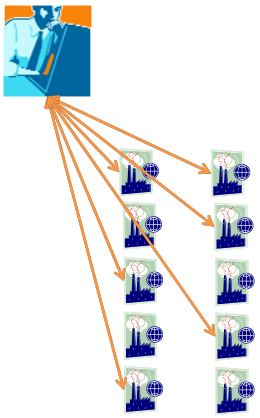
What Have We Learned?

What's Next?



Designer Approach

- KBDSS
- DIET
- IME, DIME
- IEPT

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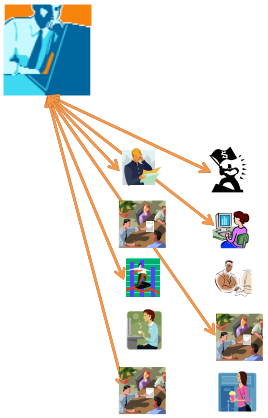
Knowledge & Networks

IS and ICT

What Have We Learned?

What's Next?



Facilitator Approach

- IEDP
- Presteo

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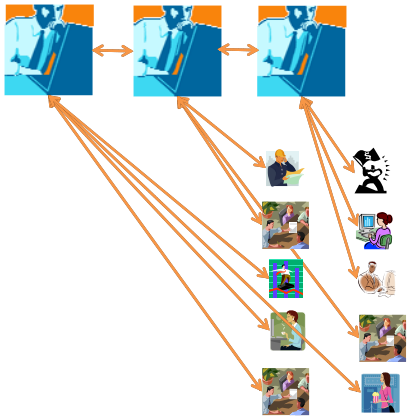
IS and ICT

What Have We Learned?

What's Next?



Networked Facilitator Approach • CRISP

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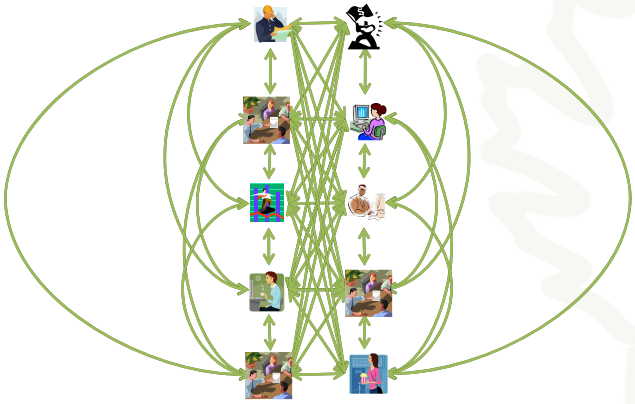
IS and ICT

What Have We Learned?

What's Next?

Future IS Knowledge Infrastructure



Networked Participant Approach • Kalundborg

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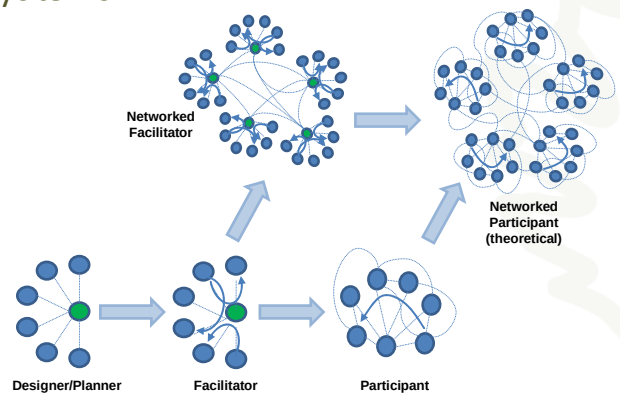
What Have We Learned?

What's Next?

Evolution of interaction within IS ICT systems



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What Have We Learned?

What's Next?

Dimensions	Designer/ Planner	Facilitator	Networked Facilitator	Participant	Networked Participant
Role of Broker or Core Firm:	• Coordination	• Support collaboration, establish network ties	• Establish and support ties between regional networks	• Same as facilitator	
Structure:	• Central hub	• Developing toward participant driven network	• Multiple hubs developing regional participant networks	• Less emphasis on central hub, multiple nested ties	• Multiple regional networks connected beyond cultural and geographical proximity
ICT Platforms and Requirements:	• GIS, design, process flow, and optimization packages available off the shelf	• Project management, Collaborative software environments	• Emphasis on distributed multi-user systems, required investment in usability	• Online community, social networking components, required investment in sociability and usability	• Heavy investment in sociability and usability in a robust online community
Knowledge Transfer:					
Motivation:	• Low-volume Explicit	• Explicit and low-volume tacit	• Low-volume Explicit	• Explicit and tacit	• High volume explicit and tacit
	• Strong commitment to central authority or mission	• Demonstrate commitment to network goals	• Demonstrate commitment to network goals, improved access to relevant knowledge	• Learn faster than competitors, benefits of participation far outweigh isolation, reciprocity	

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What Have We Learned?

What's Next?

Other Observations

1. Projects have yet to succeed in the United States
2. Academic endeavors often come to completion, but fall short of creating available tools

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IS and ICT

What Have We Learned?

What's Next?

What if we reframe our perspective on Industrial Symbiosis?

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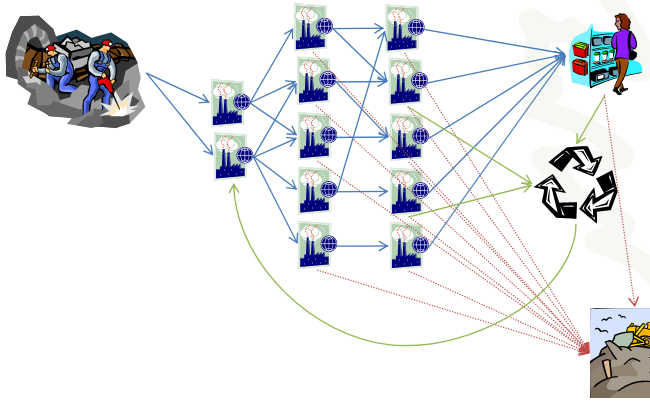
What Have We Learned?

What's Next?

What if we reframe our perspective on Industrial Symbiosis?



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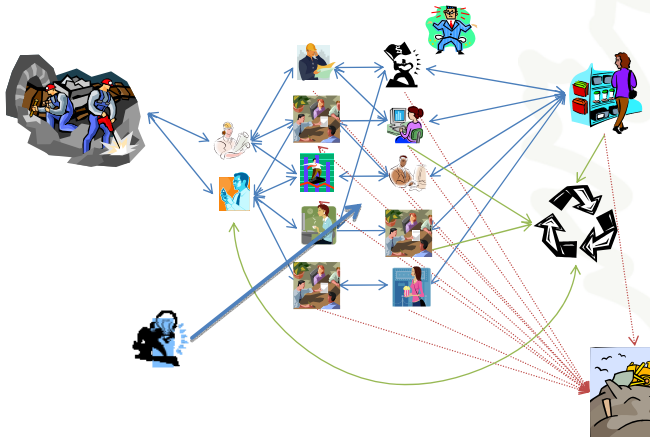
What Have We Learned?

What's Next?

Start focusing on the people.



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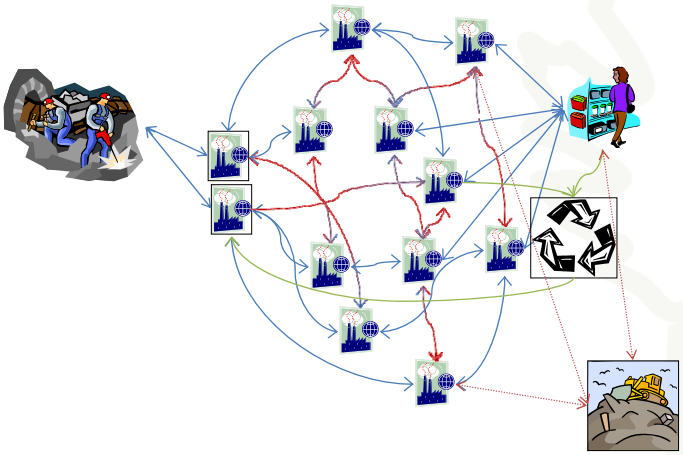
What Have We Learned?

What's Next?

… relationships instead of resource flows?



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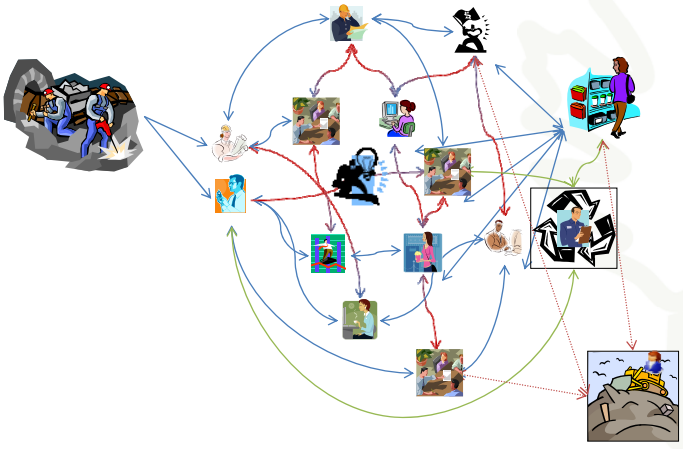
What Have We Learned?

What's Next?

What if we reframe our perspective on Industrial Symbiosis - **To support knowledge creation, transfer, and integration within a collaborative IS network**



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IS and ICT

What Have We Learned?

What's Next?

Ways Forward

1. User driven content is the core value of the system. Unlock this process and watch the system grow on its own.
2. Focus on the synergy development process rather than the resource flows. Understanding where the community exchanges knowledge will provide the starting point and roadmap for tool development.
3. Sociability! (human-human interaction). Online communities in support of offline communities.
4. Developing common resource and industrial classifications amongst the IS community would go a long way toward exchanging knowledge and synergies.

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Thank You

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Ecological Systems Engineering
Purdue University

Thank You

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p.s. if anyone here has a Ph.D. program, I'm looking to apply

Ecological Systems Engineering
Purdue University

"Today the basis of the Symbiosis co-operation of Kalundborg is openness, communication and mutual trust between the partners. The Kalundborg companies are located in a small community that has helped establish fine conditions for open and intimate working relations."

Source: The Kalundborg Centre for Industrial Symbiosis

The presentation covered Gabriel's master's thesis research. These notes cover comments/questions from the audience and responses from the speaker. The sections in italics marked "R" provide the speaker's responses to comments

Clarification was pointed out that the Toyota Production System (TPS) brings together competitive suppliers as well as different members along the supply chain. This is motivated by the idea of increasing the pie by Toyota's moving faster than its competitors even though it expects that some of the knowledge it passes on to suppliers might spill over to some of its auto-industry competitors. This model is contrasted with Wal-Mart's model of squeezing suppliers to meet targets.

Discussion

Albena Bossilkov**, **Curtin University- was asked to add how the work at Curtin fits into the list/hierarchy of IS tools that have been developed over the years. She indicated that Curtin's CSRP has developed a set of tools that includes pre-assessment, screening, and assessment. It has been applied to Kwinana and Gladstone, and is in the first stages at Geelong, and will be applied in Rustenberg. The key functions are still under development, but they expect that the software will be available by the end of the year or a little later

Gabriel Grant, Yale- suggested that IS ICT program goals should have scope of opportunity identification, opportunity assessment and barrier removal, commercialization and adaptive

management, documentation and review – the process needs to be circular rather than a linear process that starts at review rather than opportunity identification as is usually done.

There needs to be a commercialization strategy for academic projects that get done but never move beyond study phase, so that something can come out of this work.

Ray Cote, Dalhousie University– suggested that there may be some merit in looking at the link between knowledge and business management paradigms and the languages they use. This relates to suggestions at previous ISIE meetings that we build connections with other disciplines working in similar areas but calling them by different names.

Julian Cleary , University of Toronto – there is an inherent difficulty of tacit knowledge going to management; so trying to improve inter-firm communication, which is essentially communication between managers who don't have tacit knowledge, is happening in the wrong place. How do we deal with getting the tacit knowledge to flow between firms? There needs to be a less antagonistic relation between management and labor – there is an interesting lesson from GM and auto plants in Ontario – intra-firm communication is just as important. *R: inter-firm communication is just as important, knowledge management ideas started within firms and expanded out to networks, the transaction cost perspective is that everyone is out for themselves, so knowledge does not travel well between management and labor. Knowledge management is an alternative frame to consider these relationships. The role of managers in information exchange is not to coordinate companies but rather to connect people in their companies who have the tacit knowledge, and incentivize collaboration.*

Jorgen Christensen, Kalundborg– thanked the symposium arrangers for giving Gabriel the opportunity to present this work. We (in Kalundborg) have always emphasized communication, now we have some technology to do this, it is very valuable. We realized that half of our symbioses were established before the majority of communications. Last year in Lausanne, 3 things were identified as needed to make a private company enter into IS: awareness, willingness and availability. It is a decentralized not a central planning approach. Awareness and willingness have to come first rather than mapping comprehensive solutions, this puts the focus on who is attractive to whom and getting knowledge. Build social capital first, then address availability of resources last.
R: Gabriel referred to the Symbiosis Institute quote on openness and communication.

Reid Lifset, Yale– This is great work, and offers probing questions. First, I don't agree with Gabriel's characterization of transaction cost economics – that body of thought is trying to explain outcomes rather than design them. Williamson's work attempts to explain observed forms of organization, economy isn't designed around transaction costs. I'm not sure transaction cost economists would think of their work in this way. *R: transaction costs explain, in hindsight, the world we live in; a knowledge approach can't use hindsight, so is more forward looking.*

Second, the IE community has moved back and forth from descriptive and normative work, explaining vs. changing the world, so it seems that one of the questions that arises on the explanatory side concerns why EIPs have failed. There are many issues such as size, location, payoff, management – there are lots of issues that can inhibit a project's success. If a project

doesn't have high payoff waste streams, all this other stuff falls by the wayside. It's not all about management. *R: how do we go about making wrong decisions, it's all about knowledge that we can make the best decisions we can.* Reid – a high landfill tax seems to be a major driver in NISP's success. The United States doesn't have and won't have these fees, so it's difficult to compare. At some level it doesn't matter how good the knowledge is; there are other factors e.g. economics that override others such as the value of waste streams.

Qingzhon Wu, Dow Chemical – What will success look like, how will it be measured? *R: I've been looking at how many synergies are predicted, enacted, still around. My indicator is – is it still around, being used today. How do we quantitatively assess success of symbioses is a big question.*

John Ehrenfeld, ISIE– Some things are more important that knowledge. Applications in the literature are successful ones that have used a knowledge approach, but symbioses are not always successful. There are lots of waste exchanges that haven't succeeded in which information was provided. CRISP is perhaps the most developed knowledge database but it contains links that are already successful vs. the Bechtel-type models, which were all prospective. There is a particular kind of knowledge that spawns evolution. *R: CRISP has recorded failures.*

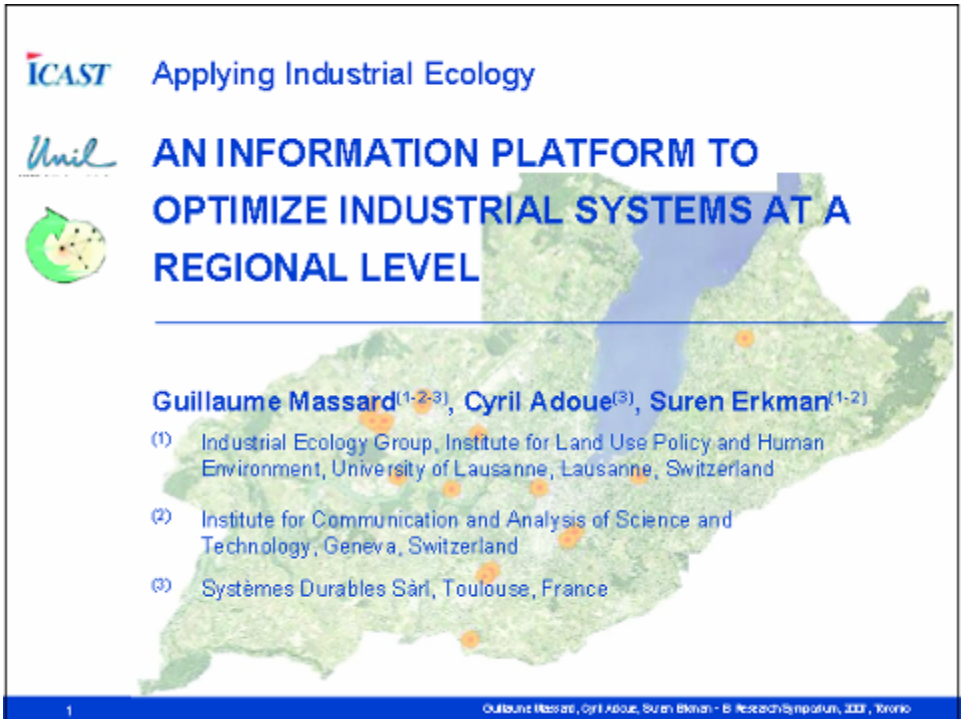
Roland Clift, University of Surrey – This work led me to think of Jesse Noyes Foundation and Bechtel initiatives in the ICT sector. They were a systematic way to manage supply chains, driven by removal of hazardous materials required by EU policy, asking suppliers if their products contain particular components, rather than sending new surveys. Suppliers and customers got together and created company wide information gathering exercises to gather information from common 1st tier suppliers and beyond. These relational teams could be a useful approach to build IS teams in future.

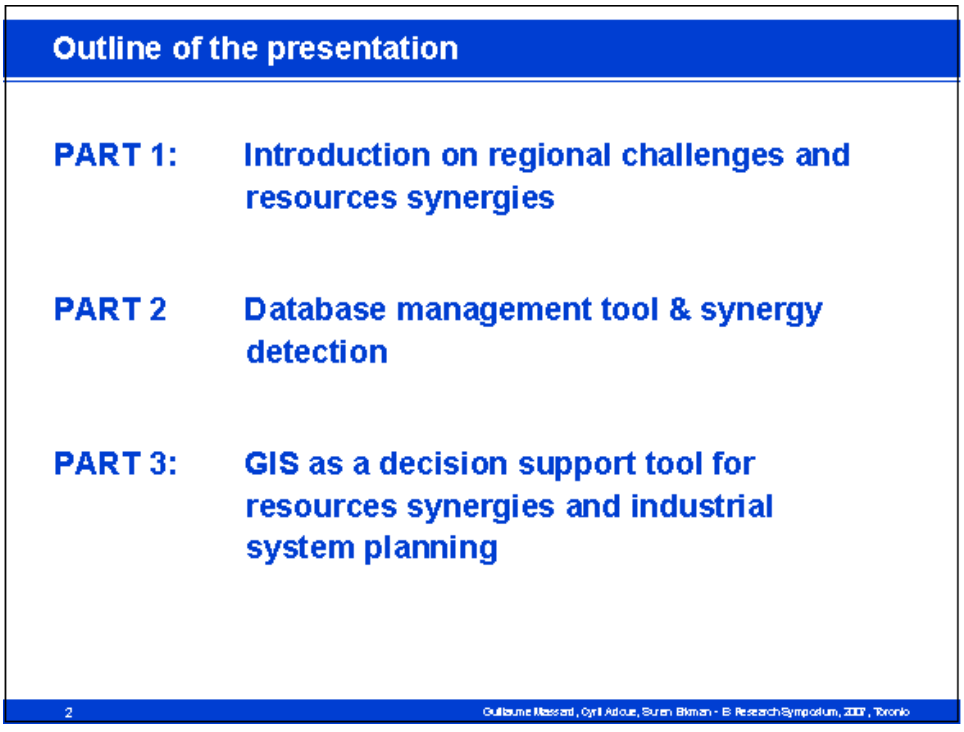
Anne Hewes, EcoMaine – Systems make it work but people make it happen – quote from Jorgen. With a change in people, it is the legacy that makes it go on.

Don Lyons, University of North Texas– tacit knowledge is important, what is the outcome, is it more than just creating successful interactions? How much do you need in an economy? *R: literature on tacit knowledge suggests that it is the critical ingredient in innovation.*

Tracy Casavant, Eco-Industrial Solutions – This isn't an either / or situation. Explicit knowledge can build tacit understanding and vice versa; how does this interplay in IS? *R: systems need to support both levels of communication, a continuum, have to support a broad spectrum.*

2. An information platform to optimize industrial systems at a regional level – Guillaume Massard, Cyril Adoue, Suren Erkman





PART 1

Introduction on regional challenges and resources synergies

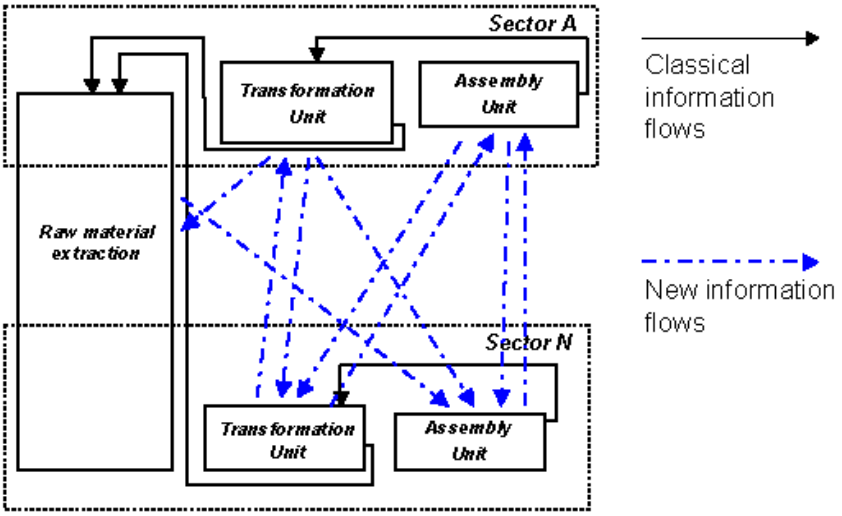
1.1 Overview of regional challenges

Industrial ecology and resources synergies opportunities at the regional level

- **Material Flow Analysis** to understand regional metabolism and prioritize action (2001 - 2002)
- Optimizing the industrial system by setting up **resources synergies networks** and creating **new activities** (2005 - …)
- **Proactive vision** and **territorial planning** for an optimum development of the industrial system (2006 - …)

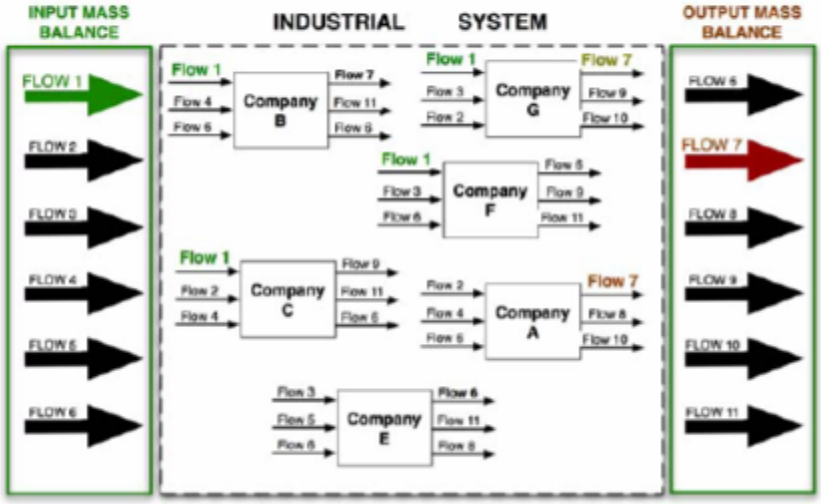
1.2 Methodology and data collection

Information flows inside the industrial system



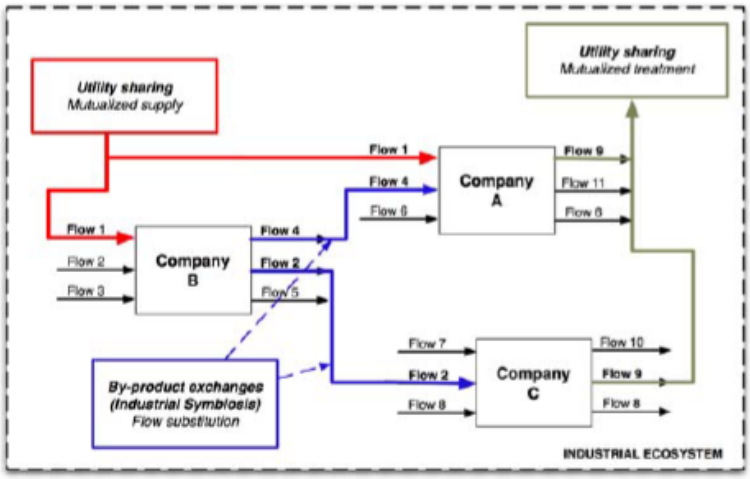
1.2 Methodology and data collection

Mass balance: industrial system understanding



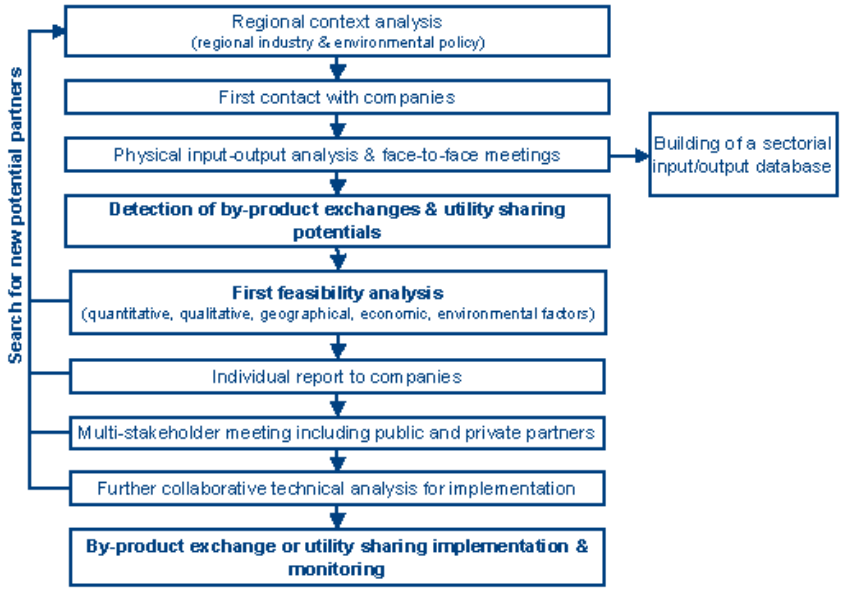
1.2 Methodology and data collection

Resources synergies: regional dematerialization and metabolism optimization



(Adoue, 2004, modified)

1.2 Methodology and data collection



PART 2

Database management tool & synergy detection

Presteo©

2.1 Database management tool: Presteo©

Origins

- 5 years of research & development
- Based on a PhD thesis:

ADOUE C., *Identification Methodology for Feasible Eco-industrial Synergies between Industrial Actors on the French Territory*, Doctoral thesis, University of technology of Troyes, France, 2004

- Tested in the French and Swiss context:
  - *Aude industrial ecology club (www.ceiaube.fr)*
  - *Ecosite committee, State of Geneva*
- Commercialized by Systèmes Durables (www.systemes-durables.com)

2.1 Database management tool: Presteo©

Main function of Presteo

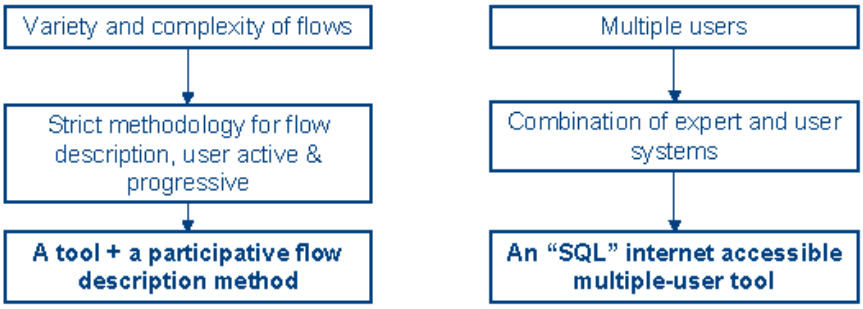
- To detect potential synergies between companies and potential new activities
- Systematic or deductive approach

Regional resources synergies projects

- Numerous industrial sectors and companies
- Geographical dispersion of companies
- Numerous local or regional industrial associations, organisms and institutions

2.1 Database management tool: Presteo©

Learning from similar tools (mainly Fast et ISIS)



2.1 Database management tool: Presteo©

Tool type

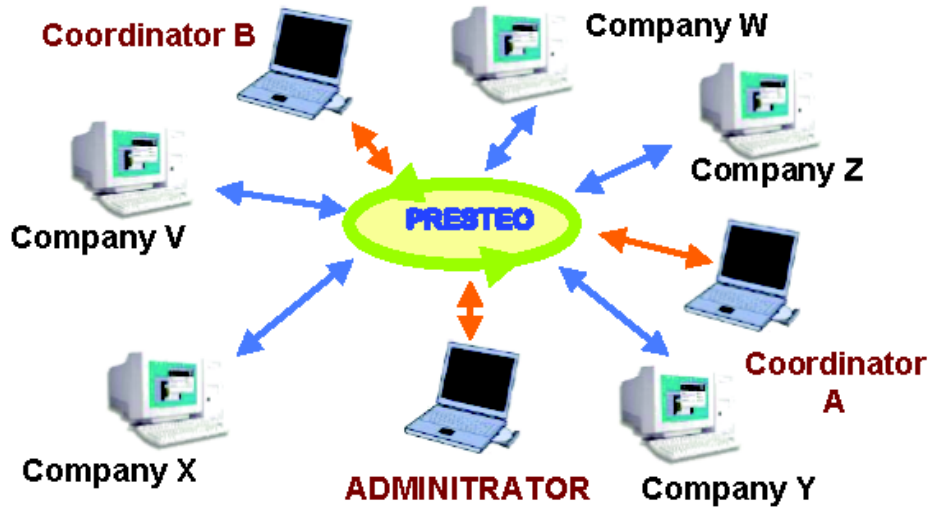
- Database tool crossing and compiling physical input-output data from companies
- Client-server tool

Need for a database management tool with…

- Taxonomy of flows according to a **precise syntax** and a **homogeneous formalism** fitting to all industrial sectors
- Accessible to project **coordinators or companies** at any time
- **Expert and non-expert user approach**
  - Non-experts (coordinators), various partners of industrial symbiosis program (companies, institutions, …)
  - Expert coordinators and administrator support for all user
- Allowing **easy update** of new information

2.1 Database management tool: Presteo©

A multiple-user and client-server tool



2.1 Database management tool: Presteo©

How to use Presteo

Create companies and user profiles

↓

Enter physical input / output balance from each companies
Flow & component levels

↓

Input / output balance control & acceptance by administrator

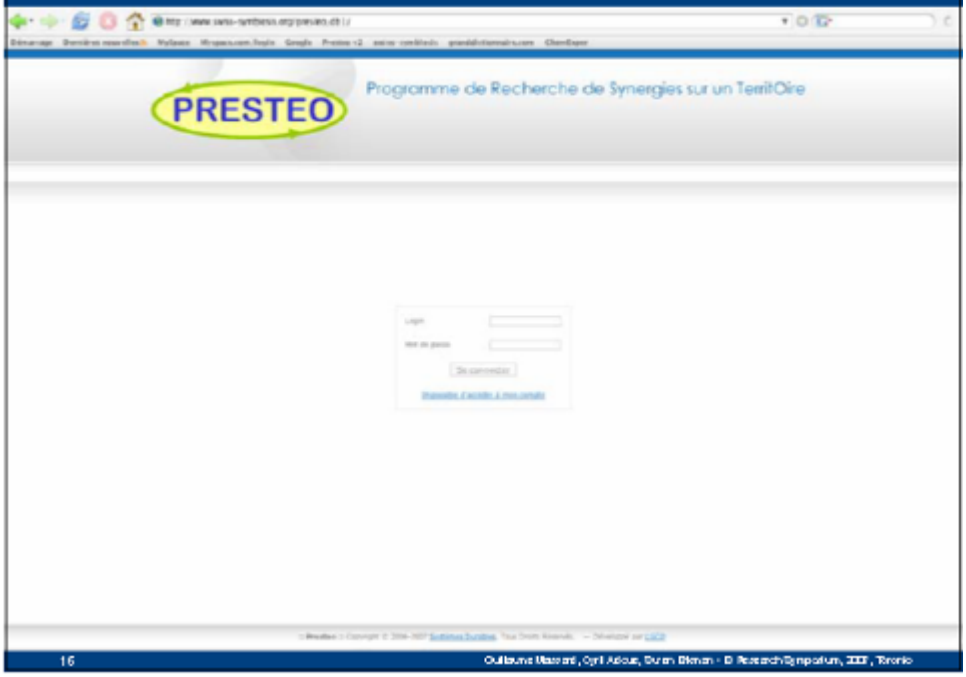
↓

Performing studies:
Symbiosis
Utility sharing
Mass balance (search per flow or component)
By waste code

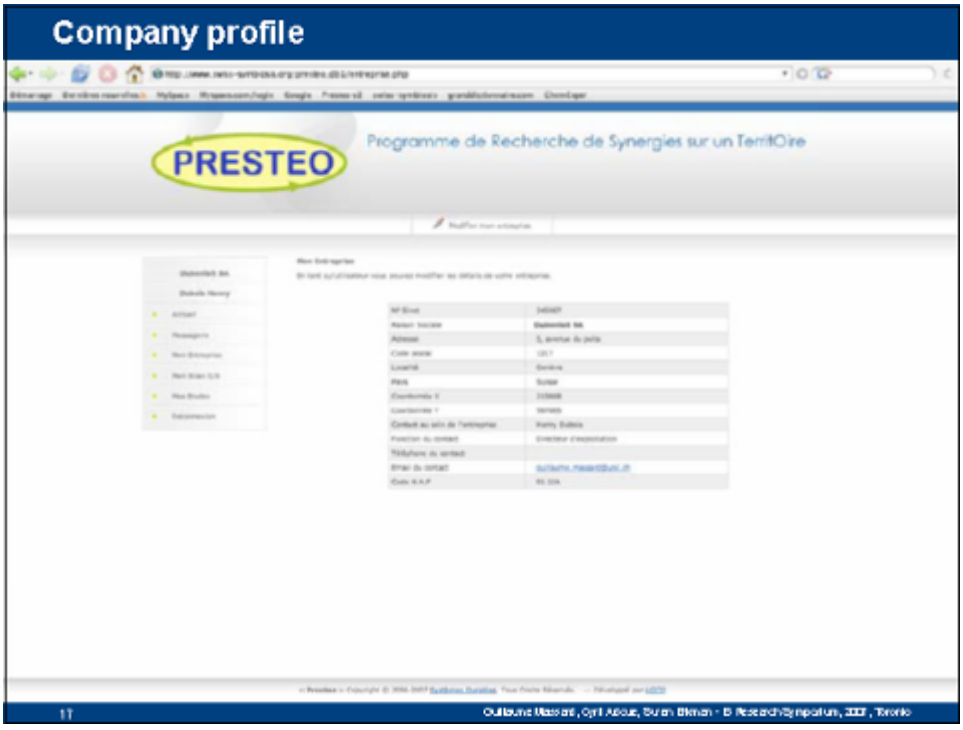
↓

Export studies to excel or to a GIS tool for further feasibility analysis

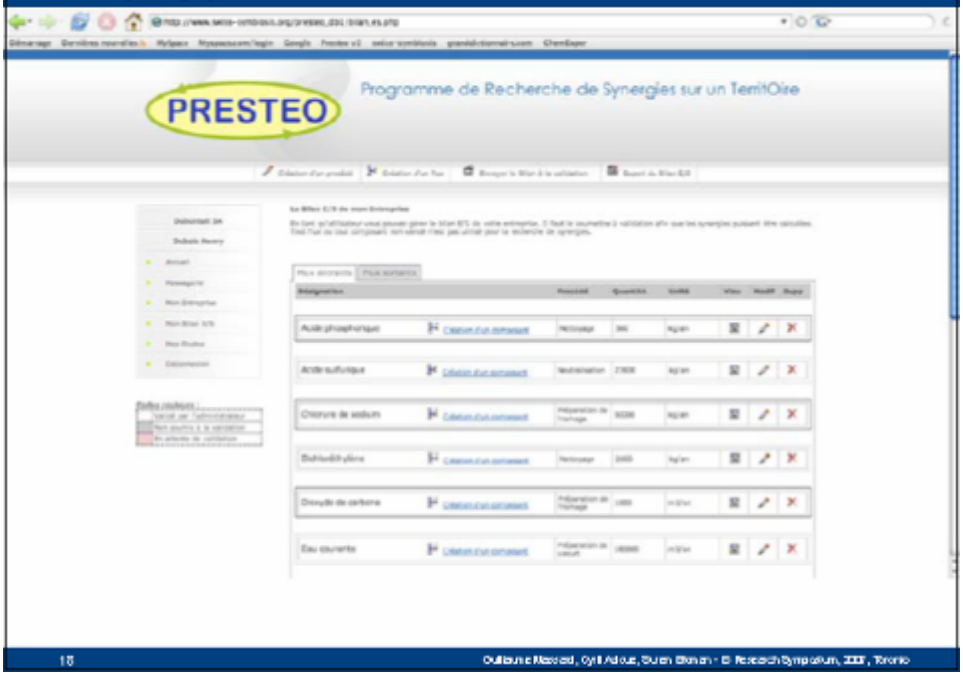
Welcome to Presteo…



Company profile



Company profile



2.1 Database management tool: Presteo©

Input / output flow description method

2 levels of description: **FLOW** and COMPONENT

- **Flow** = real input or output from a industrial process

  Ex : acid bath

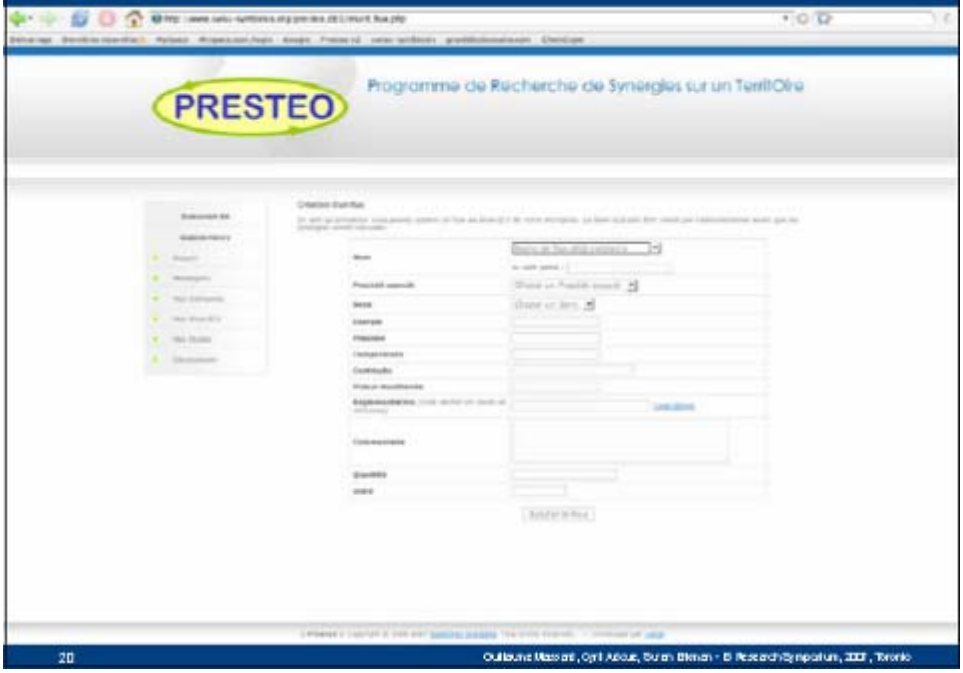
- A flow is named using its physico-chemical description

  Ex : bar of steel

- A flow can contain several components

  Ex : Metal-hydroxyde sludge

Flow description



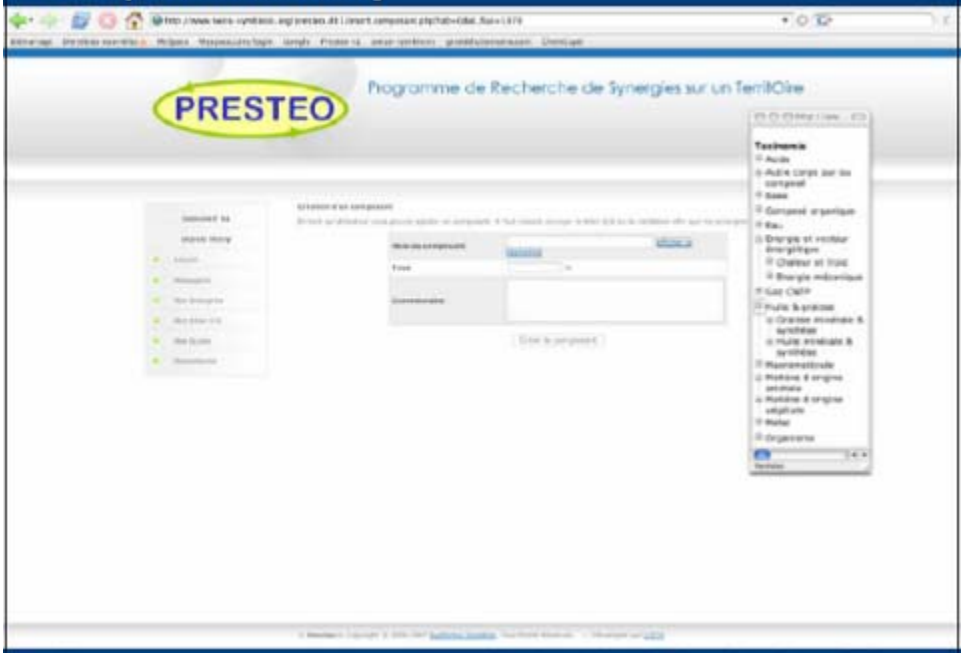
2.1 Database management tool: Presteo©

Input / output flow description method

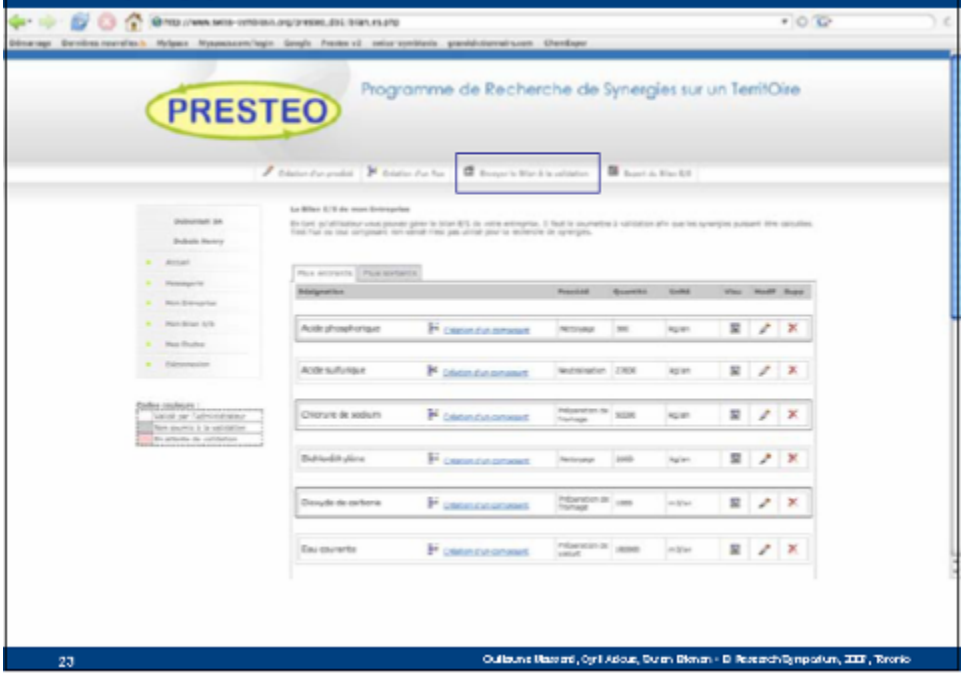
2 levels of description: FLOW and **COMPONENT**

- A flow can contain one or more components
- A component is named using its physico-chemical description
- Existing taxonomy of more than 1400 components classified in 13 categories

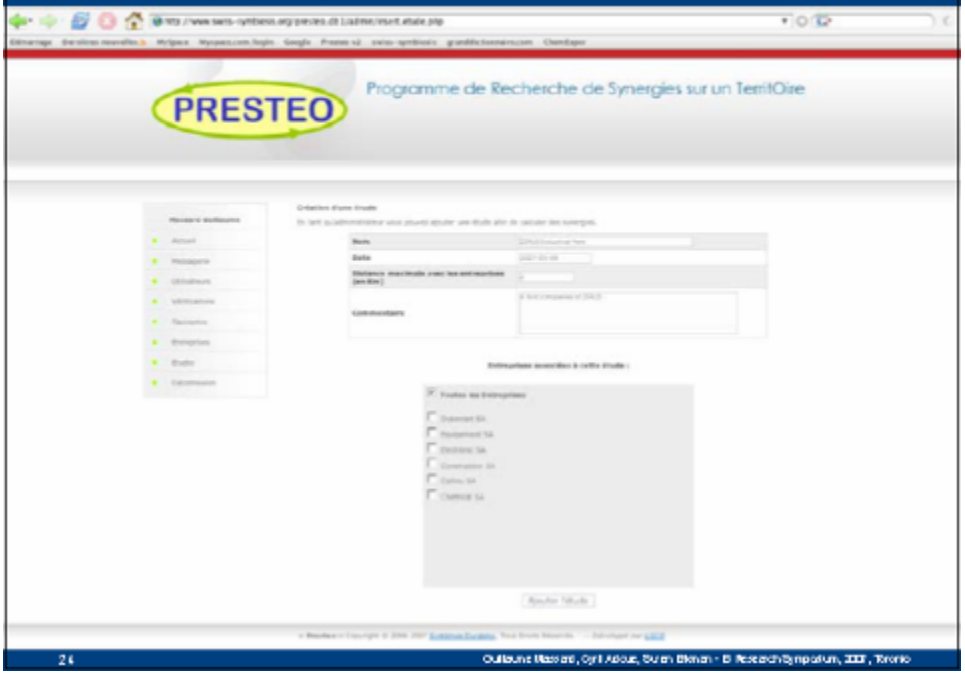
Component taxonomy



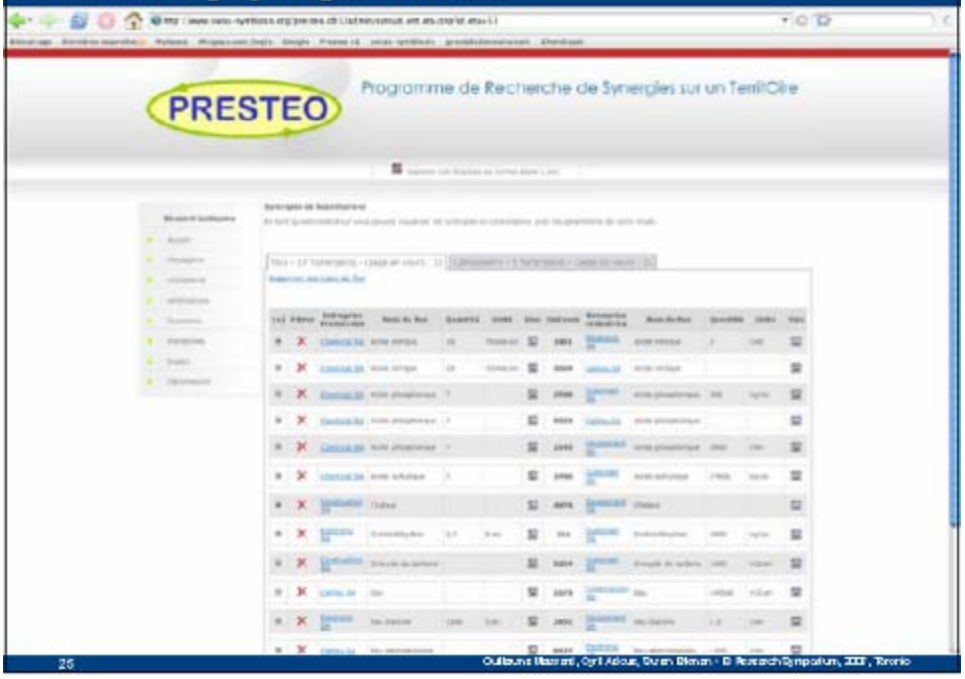
Company profile



Performing synergies detection



Performing synergies detection



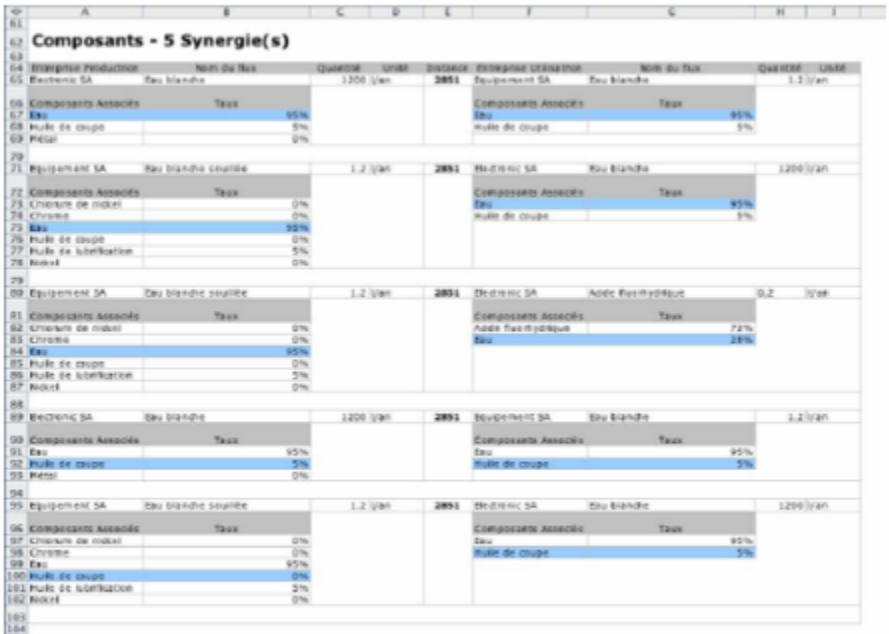
Performing synergies detection

Synergies de Substitutions

Flux - 17 Synergie(s)

Entreprise Productrice	Nom du flux	Quantité	Unité	Distance	Entreprise Utilisatrice	Nom du flux	Quantité	Unité
Chem'cal SA	Acide nitrique	19	Tonne/An	3451	Electronic SA	Acide nitrique	2	t/an
Chem'cal SA	Acide nitrique	19	Tonne/An	5924	Colliss SA	Acide nitrique		
Chem'cal SA	Acide phosphorique	?		3700	Dubonlait SA	Acide phosphorique	300	kg/an
Chem'cal SA	Acide phosphorique	?		5924	Colliss SA	Acide phosphorique		
Chem'cal SA	Acide phosphorique	?		2143	Equipement SA	Acide phosphorique	2800	t/an
Chem'cal SA	Acide sulfurique	?		3700	Dubonlait SA	Acide sulfurique	27600	kg/an
Construction SA	Chaleur			4974	Equipement SA	Chaleur		
Electronic SA	Dichlorethylène	2,5	t/an	254	Dubonlait SA	Dichlorethylène	2000	kg/an
Construction SA	Dioxyde de carbone			5354	Dubonlait SA	Dioxyde de carbone	1000	m3/an
Colliss SA	Eau			2173	Construction SA	Eau	140000	m3/an
					Composants Associés	Taux		
					Eau non potable	20%		
Electronic SA	Eau blanche	1200	t/an	2851	Equipement SA	Eau blanche	1,2	t/an
Composants Associés	Taux				Composants Associés	Taux		
Eau	95%				Eau	95%		
Huile de coupe	5%				Huile de coupe	5%		
Métal	0%							
Colliss SA	Eau déminéralisée			6927	Electronic SA	Eau déminéralisée	1200	t/an
Construction SA	Eau industrielle	2800	m3/an	4974	Equipement SA	Eau industrielle	8400000	t/an
Chem'cal SA	Hydrure de polymethylsiloxane	300	Tonne/An	2899	Construction SA	Hydrure de polymethylsiloxane	900	T/an

Performing synergies detection



2.1 Database management tool: Presteo©

An efficient tool for resource synergy detection?

Main challenges

- Search for exhaustiveness => high number of potential synergies
- Numerous potential synergies, but small number of implementations

Presteo support to feasibility analysis

- Flow specific detection studies
- Considering geographic position of companies
- Distance filter when generating results
- Linkage to GIS for further studies

2.1 Database management tool: Presteo©

Presteo today and tomorrow…

- A tool + an IS methodology + a 2 days training course
- French version commercialized in France and Switzerland :
  - Aube Industrial Ecology Club (Troyes, France)
  - Industrial area of Dunkerque (France)
  - State of Geneva (Switzerland)
  - Some other projects under development…
- English version: summer 2007

2.1 Database management tool: Presteo©

Further questions & opportunities on database management:

- Considering the temporal dimension of resources synergies projects and the difficulty to normalize flow description, is the multi-user approach relevant ?
- Is the company the good entity to be consider for data collection and analysis ?
- How to integrate production line efficiency in the resources synergies methodology ?

PART 3

GIS as a decision support tool for resources synergies and industrial system planning

3.1 Advantages of GIS based systems

In general:

- Combination of computer-based database management system with visualization and geographic analysis
- Allow collection, storage and analysis of spatial data
- Represent spatial relationship between objects and enables the computation of constraints (queries, application of algorithms)
- Database can be searched by character (value, qualities, combinations), by count and by distance
- Ability to integrate information from many different levels of details

3.1 Advantages of GIS based systems

For territorial planning:

- Allow territorial understanding at different scales by overlapping spatial layers and data
- Allow spatial problem solving such as:
  - Calculation of euclidean distance between objects
  - Definition of preferential path
  - Definition of spatial buffer
  - Choose of locations that meet some requirements
- Possible combination with other tools (like Presteo) to geographically anchor networks and processes

(Özyurt *et al.*, 2002)

3.2 Data available in Geneva

Vector data available (SITG): More than 100 layers on all territorial topics

- Land-use
- Land registry
- Parcel allocation
- Protected perimeters
- Building and facilities
- Industrial and agricultural zoning
- Surface and ground water networks
- Transportation networks: road, train, sail, public transport, bicycle
- Supply and draining networks: electricity, water, gaz
- …

3.2 Data available in Geneva

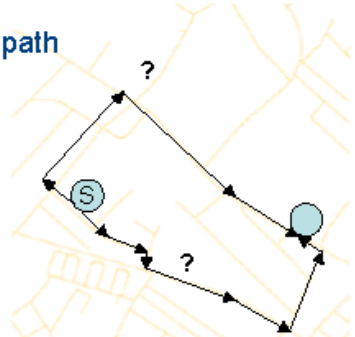
Non spatial data: industry database (DES)
More than 3'000 companies

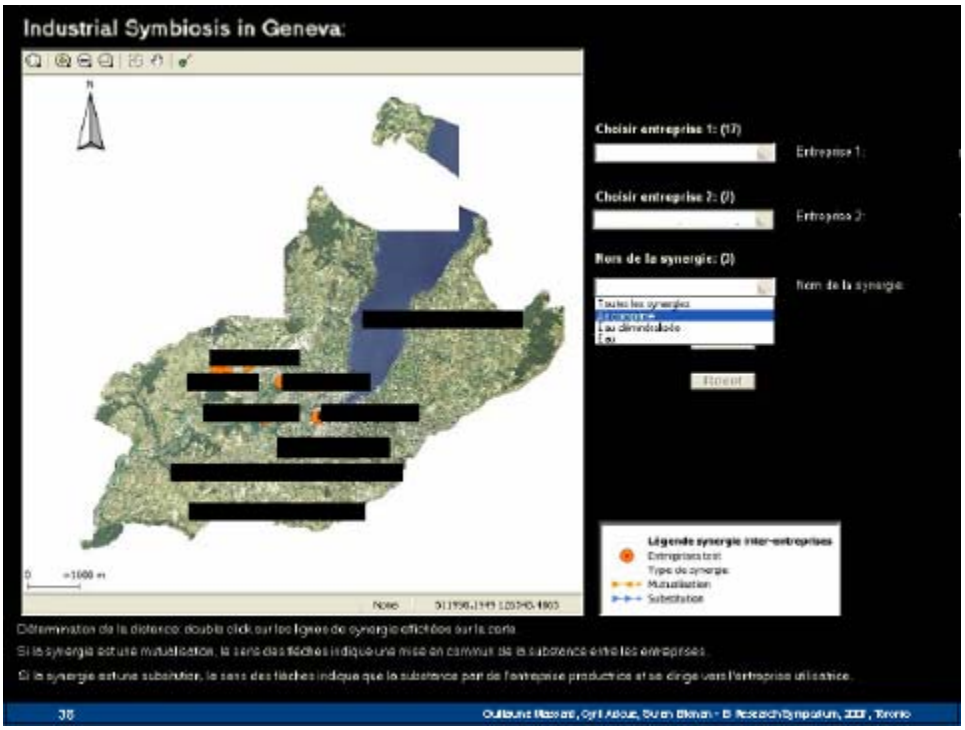
- Name
- Address
- Contact person
- Activity & Sign
- Activity code (NOGA)
- Commercial code (ID_Reg)
- Number of employees
- Geographical positioning

3.3 Applying GIS to industrial system optimization

Interface 1:
Visualizing and studying detected synergies

- Visualization of Presteo's results
- Feasibility analysis
  - Measurement of euclidean and real distance between potential partners
  - Preferential transportation means & path
  - Preferential pipeline path
  - Environmental risks evaluation




Industrial Symbiosis in Geneva:
Choisir entreprise 1: (17)
Entreprise 1:
Choisir entreprise 2: (0)
Entreprise 2:
Nom de la synergie: (3)
Nom de la synergie:
Toutes les synergies
Eau déminéralisée
Eau
Reset
Légende synergie inter-entreprises
Entreprises test
Type de synergie
Mutualisation
Substitution
Détermination de la distance: double click sur les lignes de synergie affichées sur la carte
Si la synergie est une mutualisation, le sens des flèches indique une mise en commun de la substance entre les entreprises
Si la synergie est une substitution, le sens des flèches indique que la substance part de l'entreprise productrice et se dirige vers l'entreprise utilisatrice.
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Guillaume Rosset, Cyril Abdul, Suren Erkman - IS ResearchSymposium, 2007, Toronto


Industrial Symbiosis in Geneva: detected synergies
Choisir entreprise 1: (17)
Entreprise 1:
Choisir entreprise 2: (7)
Entreprise 2:
Nom de la synergie: (3)
Nom de la synergie: Eau
Visualisation:
Reset
Légende synergie inter-entreprises
Détermination de la distance: double click sur les lignes de synergie affichées sur la carte
Si la synergie est une mutualisation, le sens des flèches indique une mise en commun de la substance entre les entreprises
Si la synergie est une substitution, le sens des flèches indique que la substance part de l'entreprise productrice et se dirige vers l'entreprise utilisatrice
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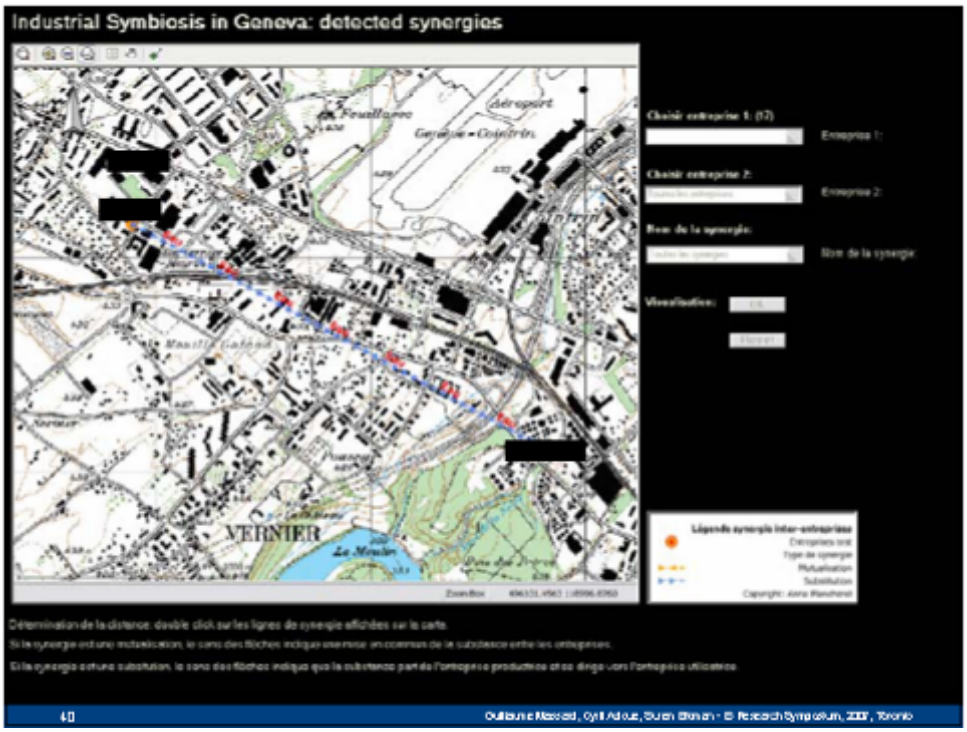


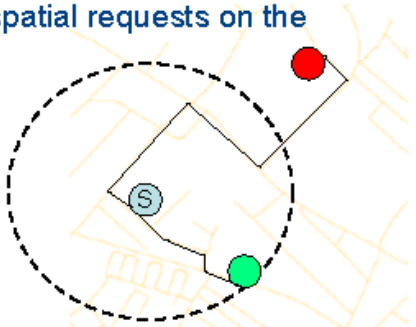
3.3 Applying GIS to industrial system optimization

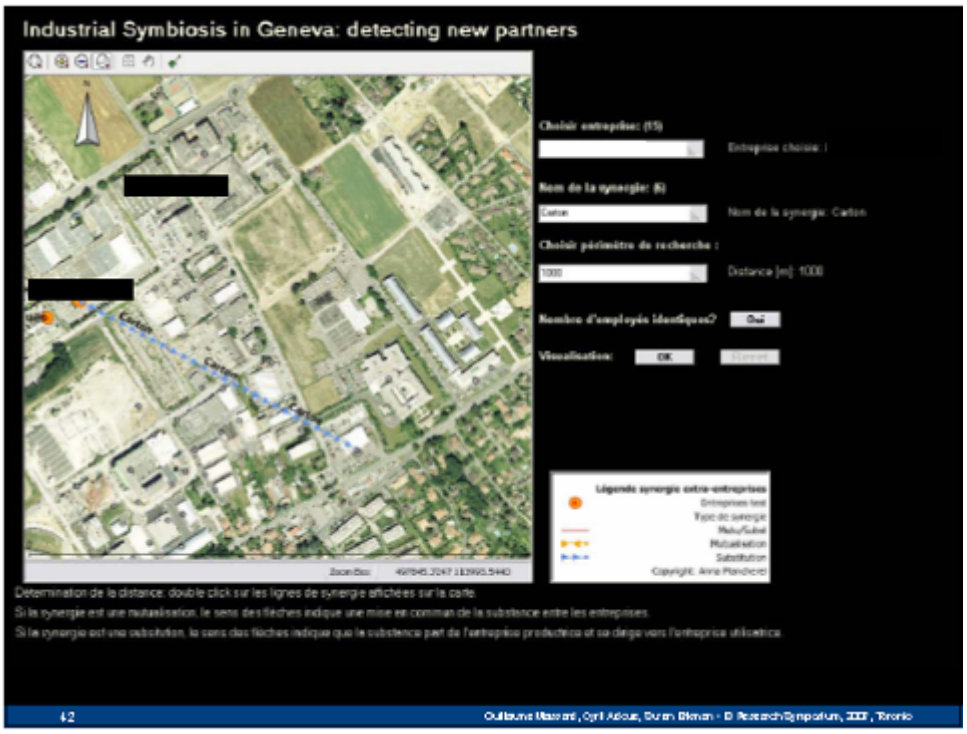
GIS Interface 2:
Detection of new potential partners

Potential synergies may reach an impasse because of geographical, technical or interest barrier

⇒How to detect new potential partners?

Creation of spatial buffer through spatial requests on the company database.




Industrial Symbiosis in Geneva: detecting new partners
Choisir entreprise: (15)
Entreprise choisie :
Nom de la synergie: (6)
Carton
Nom de la synergie: Carton
Choisir périmètre de recherche :
1000
Distance [m]: 1000
Nombre d'employés identiques?
Oui
Visualisation:
OK
Légende synergie extra-entreprises
Type de synergie
Mutualisation
Substitution
Copyright: Anne Pianchetti
Détermination de la distance: double click sur les lignes de synergie affichées sur la carte
Si la synergie est une mutualisation, le sens des flèches indique une mise en commun de la substance entre les entreprises
Si la synergie est une substitution, le sens des flèches indique que la substance part de l'entreprise productrice et se dirige vers l'entreprise utilisatrice
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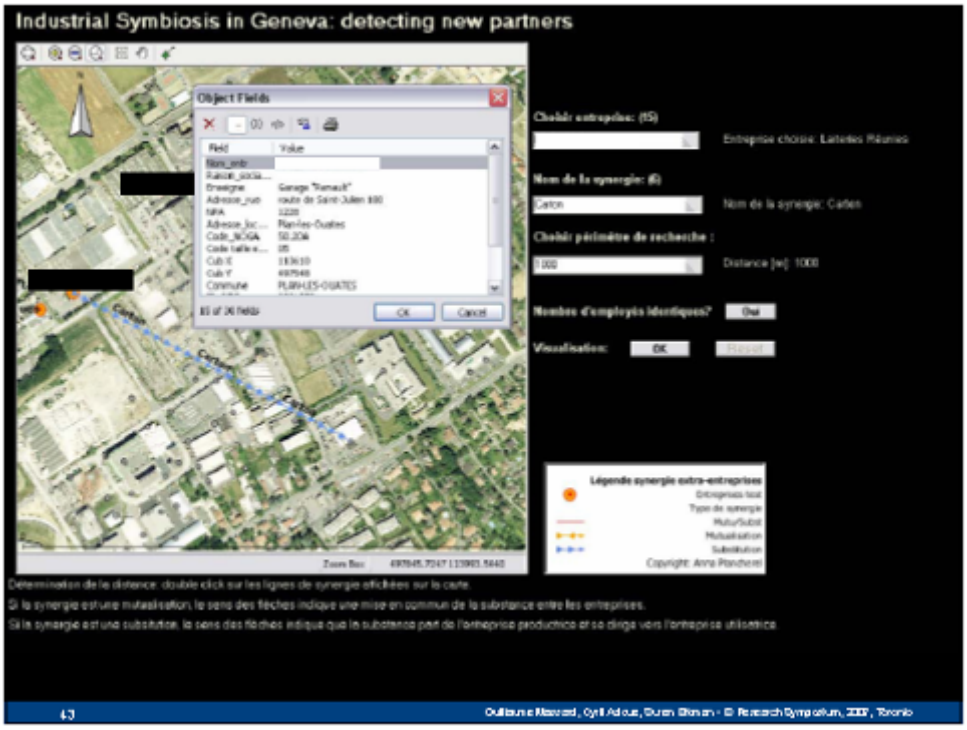
Industrial Symbiosis in Geneva: detecting new partners
Object Fields
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Entreprise choisie: Laiteries Réunies
Nom de la synergie: (6)
Carton
Nom de la synergie: Carton
Choisir périmètre de recherche :
1000
Distance [m]: 1000
Nombre d'employés identiques?
Oui
Visualisation:
OK
Légende synergie extra-entreprises
Type de synergie
Mutualisation
Substitution
Copyright: Anne Pianchetti
Détermination de la distance: double click sur les lignes de synergie affichées sur la carte
Si la synergie est une mutualisation, le sens des flèches indique une mise en commun de la substance entre les entreprises.
Si la synergie est une substitution, le sens des flèches indique que la substance part de l'entreprise productrice et se dirige vers l'entreprise utilisatrice
43
Guillaume Massard, Cyril Adoue, Duran Ekman - © ResearchSymposium, 2007, Toronto

3.3 Applying GIS to industrial system optimization

Conclusions & work in progress

Today:

- Several GIS interfaces linked to Presteo to support feasibility analysis
- GIS knowledge needed to manipulate them

Objectives:

- Build an accessible tool usable by institutions managing industrial systems

3.3 Applying GIS to industrial system optimization

Further questions & opportunities on GIS:

- How to include GIS based industrial planning as an element of the territorial planning policy ?
- Industrial Symbiosis is only one of the elements for regional industrial planning and optimization. Can we include all data and challenges in one unique tool ?
- How to open advanced GIS interfaces to decision-maker and companies ?
- Data are region specific. How can we built a reproducible system ?

The following notes cover comments/questions from the audience and responses from the speaker. The sections in italics marked "R" provide the speaker's responses to comments.

Discussion

Clarification was sought on ease of doing byproduct exchanges (or why Switzerland is different). Swiss law is subject to much interpretation at the provincial level, which makes byproduct exchanges easier as wastes are not strictly defined. For example, hazardous materials (wastes) have to be tracked, but there are not restrictions on how they must be disposed.

Albena Bossilkov, Curtin University of Technology– How do you know what is in a sludge stream? Question arose regarding matching sludges for potential reuse. *R: companies know because they identify the valuable, recoverable materials in the streams.*

Roland Clift, University of Surrey - So Geneva seems different from most places, how do you know whether certain streams have certain concentrations over time (this is important for IS as these would potentially be someone's raw material)? *R: in-person interviews get at detailed info and variability.*

Qingzhong Wu, Dow Chemical Co. – From an industry perspective companies can control variability of the sludge streams if it is being sold to another user, based on customer specifications.

Don Lyons, University of North Texas – What about the problem of malfeasance – might some companies lie about their waste streams? *R: such information only comes out later, during deeper analysis to determine the actual feasibility of matches.*

3. The symbiosis is in there somewhere: Mining, analyzing, organizing and presenting data to foster industrial symbiosis- Tracy Casavant

The Symbiosis is in There Somewhere

Mining, Analysing, Organising and Presenting Data to Foster Industrial Symbiosis

City of Greater Sudbury & Other Canadian Experience

Industrial Symbiosis Symposium 2007
Greater Sudbury Synergy Tool

Presentation by Tracy Casavant

Part One: The Greater Sudbury Synergy Tool Version 1.0 (or is that 0.1?)

The Story of an Ambitious Project

- Background
- Technical Info
- Synergy Tool status
- Lessons learned
- The future of the Synergy Tool

Request for Proposals

"Provide computer program/database(s) … to track volumes of waste materials and industrial/ commercial byproducts generated within the study area, and in turn quantities that are reused/ disposed including available energy sources and services. Data will be defined by product, sector, description, format, source, quantity yearly, cost per tonne to dispose, and possible uses of products. The program will include the ability for the user to easily query data, and update the information on an ongoing basis. As an option, the program should be connected to the City website so that the general public could query the contents."

Data Requests

- From City: GIS layers (e.g., zoning); list of businesses and related information; solid waste data; related reports and studies
- From City-owned utility company: electricty and water consumption for industrial businesses
- From Businesses: Survey re: resource use, interest in eco-industrial activity

Data Received

- From City: GIS layers (e.g., zoning);
- From Businesses: Limited survey responses
- Decision made to purchase data from a third party source
- No utility data, no solid waste or other materials data
- Challenges with other data (discussed later)

Synergy Tool Initial Design Parameters

- Web-based interface, accessible to public
- Protect confidential business information
- Support scaleable / zoomable imaging
- Businesses & City can keep adding data
- Easily searchable
- Provide graphic and tabular output
- Clearly illustrates eco-industrial opportunities
- Interface with City's IT and GIS

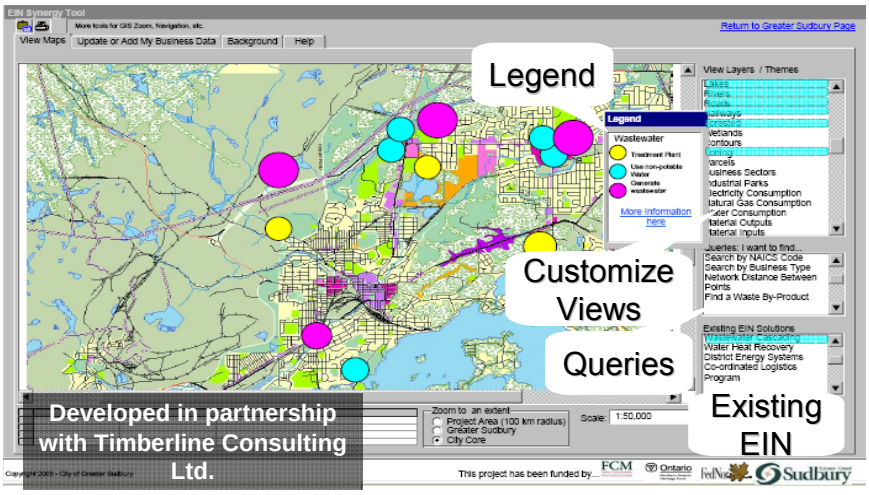
Technical Description

- ARC IMS (GIS)
- Oracle database
- Web-based interface

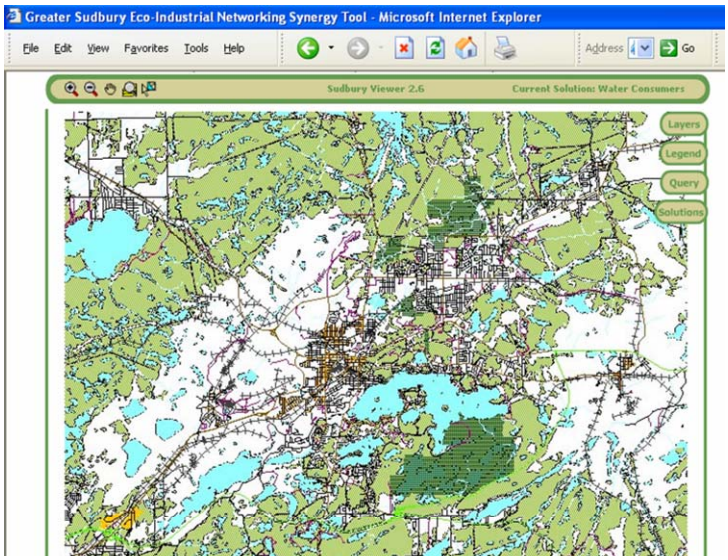
Anticipated Data Contents

- Business names, locations, and types
- Business resource flows
  - Quantitative and qualitative
  - Water, wastewater, materials, energy
- Land use & built space
- Infrastructure systems

Initial Visual Feel

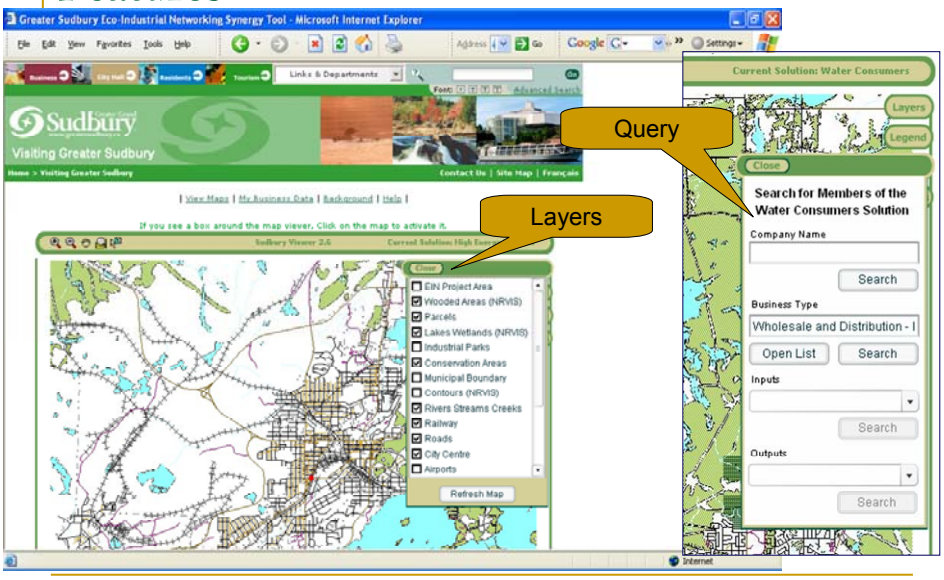


Refined Visuals



Industrial Symbiosis Symposium 2007 Presentation by Tracy Casavant
Greater Sudbury Synergy Tool

Features



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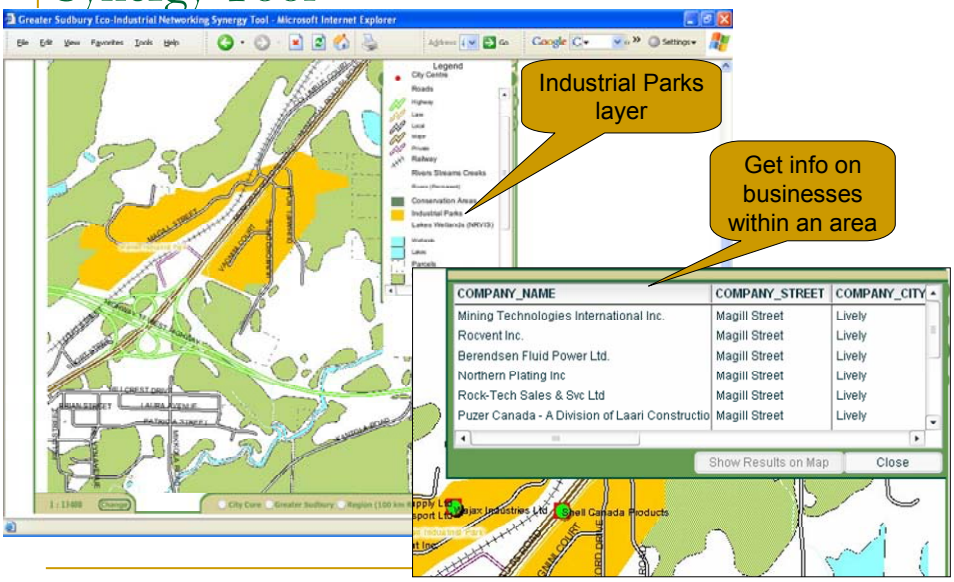
Greater Sudbury Synergy Tool

Synergy Tool



Synergy Tool – Lessons Learned

- City of Greater Sudbury is a product of the amalgamation of several recent municipalities
  - 'City' data mostly limited to previous urban area
- Data promised ≠ data delivered
  - Great strides have been made re: porting City data to GIS, but many gaps / inaccuracies exist
  - City's utility company was expected to be a key asset to project

Synergy Tool – Lessons Learned

- Disconnect between some policies (e.g., zoning) and programs (economic development, climate change)
- Private contractors responsible for solid waste collection, meaning little information on materials use is available

Synergy Tool – Lessons Learned

- Municipalities should provide consistent and strong leadership
  - Municipal staff are stretched thin
  - Original terms of reference set by different people responsible for managing project… and different people responsible for implementation
- Municipal staff have high expectations of the private sector… and vice versa

Synergy Tool – Lessons Learned

- Much more one-on-one meetings, relationship building, education & outreach would have strengthened support for tool
  - These 'soft' items can be time-consuming and costly, and don't create a 'deliverable'

The Future of the Synergy Tool

- City staff recently formed an interdepartmental sustainability team
  - Interest in eco-industrial activity is high
  - Synergy tool will at least be promoted
- Tool for local academic institutions to support eco-industrial research
- Technical upgrades
  - Corporate business development?
  - Research partnership?
  - City-led upgrades not likely a high priority

The Future of the Synergy Tool

- Key outcome of overall project is support for an eco-industrial park retrofit and new development
  - Interdepartmental support
  - Area has several keen & progressive businesses
  - Initiative will raise awareness → synergy tool may emerge with a higher profile then

Part Two: General Comment on Information Technology & Industrial Symbiosis Experience

Industrial Symbiosis Symposium 2007 Presentation by Tracy Casavant
Greater Sudbury Synergy Tool

Lessons Learned

- 'Dirty Data' is common
  - Incomplete / inaccurate data sets
- Lack of standards / compatibility
- Obtaining data takes time, sometimes $, and negotiation
- "GIS guys / gals" often isolated from rest of organization → datasets often don't contain what they could / should

(from Map It! Presentation)

Lessons Learned

- Municipalities do have a wealth of information that can support industrial symbiosis, and it's getting better
- Stakeholder engagement is critical to obtain any information from businesses
- Managing data from multiple sources is tricky but key
- GIS has been a great help in communicating opportunities

Next Steps – Our Work

(from Map It! Presentation)

- Continue to refine analytical capabilities
- Encourage clients to build off of previous work e.g., Synergy Tool
- Internal research and analysis to link our projects together and create a richer picture of eco-industrial activity

Next Steps – General

(from Map It! Presentation)

- More interdisciplinary education
  - Basic GIS included in professional training
- Recommended: An IE-GIS users group
  - Web based discussion forum
  - Information exchange
  - Collaborative research
  - Engage businesses & governments in applied pilot projects

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Our Associates – Timberline Consulting Ltd.
Our Funding Partners – FedNor, Green Municipal Funds

The following notes cover comments/questions from the audience and responses from the speaker. The sections in italics marked "R" provide the speaker's responses to comments.

Discussion

Anthony Chiu, De La Salle University-Manila – Could solid waste data come from EPA? *R: Only some data, eg. Hazardous materials, and some of this we would have to pay for.*

Albena Bossilkov, Curtin University – If you are not able to get data from the companies, are there any other trust worthy sources?. *R: we can guess what byproducts exist for different companies based on their product output.*

Jennifer Howard-Grenville, Boston University– who was the main user for the program? It sounds like businesses were not really bought in. *R: the vision was that businesses would use the system for finding synergies. It is more likely to be a tool for economic development/planning staff, we would expect that business use might ramp up over time, especially as we address social/relational issues. We decided it was more important to get people together who could have potential exchanges rather than the technical feasibility of an exchange by needing to know exact data.*

Jennifer Howard-Grenville, Boston University– what incentives are there for firms to participate, are there specific drivers why they would want to enter data? *R: For some of the businesses, the answer is cost, e.g. one business that landfilled wood waste was interested in attracting another firm to the region by pooling its needs with others in similar fields. Some firms are interested in the environmental aspects – they are motivated by wanting to do business better.*

Abhishek Agarwal, Gordon University – what are the resource implications, will there be continued funding for the program once it is implemented?

General Discussion

Paulo Ferrão, Instituto Superior Tecnico– (question to Guillame) When you map possible synergies, more often than not, the flow may not fit exactly to the other firm/process and will need intermediate processing in order to be used. How do you tackle this in the software, or do you accept intermediate technology in the program? In the EU it makes a difference as to whether there is an intermediate step; it there is then it is recycling and not byproduct exchange, about which (the former) has a lot of regulations and restrictions.
Guillame – we are looking for byproduct exchanges and utility sharing, so we may run into some of that problem. We have some projects in Geneva, e.g. some small companies send used oil to be centrifuged and repurchased. If it cannot directly be reused by the small companies, then it has to be treated for other local reuse. In Switzerland this is not seen as a problem if it is symbiosis or recycling.

Paulo Ferrão, Instituto Superior Tecnico – The Swiss can reinterpret law, but we cannot.
Guillame – if we attract a new company then it would be subject to recycling law, this can be done in a week so it is not really a problem.

Paulo Ferrão, Instituto Superior Tecnico – On the software side, does it detect a potential link if an intermediate step must be taken, or identify what intermediate processing needs to take place?
Guillame – the program will show all material links (based on the same materials), but the user has to look at it and decide whether an exchange can actually be done based on the amounts, values, quality.

Albena Bossilkov, Curtin University– In our software tool, for example, in examining waste heat development, there is a choice of technologies available that are used to estimate cost or ROI based on certain quality parameters of the waste heat stream. This is then able to give an indication of the feasibility.

Tracy Casavant, Eco-Industrial Solutions– I don't think that is the objective of the GIS tool. Those problems are more process simulation oriented, and the trick is determining whether we can create information exchange between process models and feed them into IS models.

Joe Stano, UBC – there is a German team doing process models that will be presented at ISIE.

Abhishek Agarwal, Gordon University– If innovation is required in order to make an exchange, can that be incorporated – would it show up in software?

Albena Bossilkov, Curtin University– I think we are expecting too much.

Abhishek Agarwal, Gordon University– CRISP is used for identifying links, and the team can look at innovations that are needed.

Tracy Casavant, Eco-Industrial Solutions– It is still people making those decisions, not the software.

Gabriel Grant, Yale– Chemical engineering software already exists that can be used to guide different options.

Qingzhong Wu, Dow Chemical Co. – (to Tracy) Have you looked at why there was such a lack of participation by industry?
Tracy – the main issue was that this was a city-led initiative that not many people knew about, they didn't have good strategy. The project manager was able to reach some businesses but there was not a lot of effort put into promotion and education, no large events to announce it, so it was difficult to get businesses excited to fill out the survey.

Qingzhong Wu, Dow Chemical Co. – communication is key, it's clear that the surveys were not very effective.
Tracy – the companies we reached directly were very responsive.

Jorgen Christensen, Kalundborg– Developing useful tools would be a goal in itself, but our goal here is to use IS in practice. We have seen consultants that have made projects with or without tools, they were able to present solutions that were well thought out and economically fine but did not succeed cause they weren't sold in the right way, companies did not want to buy it because they were not "invented there." I am not surprised that there were many cases where you did not get any answers from companies, but you did get positive results from companies who you did contact –so this speaks to social capital.

Marian Chertow, Yale– (to panel) Our research group also went down this road, using ArcGIS, web-based software and it seemed that the database is more important. Do we need to know spatial relationships to make it usable?
Gabriel - most planning models that use GIS use it as a visualization, communication tool for encouraging companies to participate, rather than for optimizing links.
Tracy – GIS is helpful for analyzing things like how many companies in a park are within 5 min walking distance.

Cecilia Haskins, NTNU– Once we get the GIS thing sorted out, another potential for GIS is to enable transparency to larger groups of stakeholders – community. Tracy, this was listed as an objective in your proposal – is it a relevant future application for having GIS integrated into the system?
Tracy – the objective was to have the synergy tool available online, and even if you are not a business, you can look at layers online, it can then evolve to be more useful. Guillame – there were two parts to my presentation – for the database, GIS is not needed to identify potential exchanges, however, GIS is useful once they have been identified. As soon as you want to do territorial planning, since this is all managed using GIS, we are not working with it and it is still not linked with PRESTEO, because it has to link with the Swiss tool.

Joe Stano, UBC– In Canada the sustainability infrastructure is routed in GIS, so having software tools that could integrate into GIS would capitalize on what is being done.

Anthony Chiu, De La Salle University– In a 2001 demonstration project in China, one component was awareness and preparedness for emergency – GIS was helpful for this.

Don Lyons, University of North Texas– As a geographer, I think GIS is important, but we're privileging a particular geographic scale before we know what the best/realistic scale is. IS is broader than a single scale. Most economic flows are global.

Paulo Ferrão, Instituto Superior Tecnico– On reflection it is clear that this is a rich field for R&D, is this field mature enough to have consultancy? Municipalities are strange clients, there are many buzzwords that are used and that could lead to failure because of misuse. That can be the case here if we have a product that is not well developed, so we need to separate university research and consultancy.

Marian Chertow, Yale– Some of this goes to consultants and engineers, some of it isn't ready and hasn't been thought through completely, and some things have progressed to everyday use. The transition period could be prolonged.

Tracy – I think of necessity – our objective is to motivate change in business operations; there has to be constant going back and forth between consulting and research. In most of our work, I can see research projects spinning off of our work, and I find it valuable to hear about research that's going on here. The field we are in is all about working with business.

Roland Clift, University of Surrey– What's happened in NISP and where they have been successful is related to their pragmatic attitude –i.e. get out and do it, and all the while, they've been looking for academic input to help them understand some things.

Ray Cote, Dalhousie University– The outcome of Tracy's project could actually be figuring out what can be done, what works, and the lessons that they learned can be used in setting up another city's effort.

Marian Chertow, Yale– Drawing from Gabe's presentation, a public sector client lives in an open source world, however, for companies in a world of information expropriation where they don't want their information known, there is a head-on clash that is hard to bridge because of different paradigms, there is no easy answer.
Gabriel – I refer to a comment from Peter Laybourn last year in that they (NISP) were well prepared with non-disclosure agreements but that wasn't an issue, whoever is facilitating plays a big role in how it is seen.

Marian Chertow, Yale– The key variable seems to be what information is being shared and whether it is information on the core business or not.

Cecilia Haskins, NTNU– Information sharing requirements are emerging in Corporate Social Responsibility (CSR), Supply Chain Management (SCM), as well as here. Increasingly corporations want to be seen as good citizens. If there is a layer that says this is what it takes to be a good corporate citizen, then the idea is companies will want to see themselves on that layer. Whatever it takes, whatever information is demanded for transparency, that level of information that doesn't jeopardize privacy concerns and satisfies the public's right to know.

Ray Cote, Dalhousie University– Companies have to provide some information to agencies that does become public, but often they don't want to put it in other public reports, so companies are a bit schizophrenic when it comes to information dissemination.

Anne Hewes, EcoMaine– A question on the qualitative method to Tracy – how were the surveys administered?
Tracy- we met with some companies and were able to fill out surveys during those meetings. We mailed questionnaires to 200 of 900 businesses using criteria to deem which businesses were "progressive." We talked to personnel at the economic development department to identify companies that were most progressive, and followed up with some of them.

Anne Hewes, EcoMaine – I think this emphasizes the need for one on one communication.

Anthony Chiu, De La Salle University– There is difficulty getting companies to meet. In the Philippines, industrial parks have a management team and when they call a meeting everyone comes. We have a law that every company has to have a fulltime pollution control officer to update the company of new environmental law. Also, companies have to report quarterly waste streams to government. The first stage is awareness, so there will be a first meeting called by the management team (eco-gathering); at the second meeting we administer a survey, and get >80% return on surveys.

Gabriel Grant, Yale– There is a human component that we have to consider. It is not just a problem of getting information from businesses, we need to consider ways of incorporating the human touch on websites, for example instead of company profiles, use personal profiles to get to know people in the companies.

Don Lyons, University of North Texas – There is a sociologist named Don Dillman who has been studying interview techniques, and he has been able to develop a mail survey technique to get >40% response.

Ray Cote, Dalhousie University- Ramsey Wright was able to get a phenomenal response rate of 75% on a survey of 200 companies in Burnside Industrial Park

Qingzhong Wu, Dow Chemical Co. – There is the human element in communication, also important is asking the right question to the right person; so in doing this work you should not rush for answers, but try to find the right person first.

Anthony Chiu, De La Salle University – getting answers must be done through the right channels, for our university research we can distribute a survey to 100 companies and get a poor response if we do not go through park management.

Julian Cleary, University of Toronto – I have had a similar experience, in my first round of surveys, I got 5% response, but in the second round this went up to 75% - which speaks to persistence and the need to go back to them.

Wrap- up

Marian Chertow, Yale– I don't have a big agenda for the wrap-up. We want to do some evaluation asking how did we do, what can we do better, are there some synthetic ideas that we can pursue? The foremost question on my mind is that we have no plan for next year's meeting. The next Gordon Conference is in New Hampshire. Is there value in having four annual meetings in a row? We need ideas for next year – we need to decide if we are going to do it. The floor is open.

Potential topics

Cecilia Haskins, NTNU– Can we explore collaboration with Supply Chain Management and Corporate Social Responsibility? How could these be leveraged as a theme, links with information model, networking. It can also be useful as a way to challenge our models.

Anthony Chiu, De La Salle University – There is definitely a connection with SCM – there is a supply chain information web in Asia - center-satellite production system.

Guillame Massard, Universite de Lausanne– Looking at the symbiosis literature, can we get people who have implemented projects, in order to understand the technical factors, and see their business plans?

Gabriel Grant, Yale– In addition to people on the ground, different academic perspectives can be brought in that correlate with their work

Gemma Cervantes, Universitat Politecnica de Catalunya – I'd be interested in looking at measuring and indicators for IS.

Qingzhong Wu, Dow Chemical Co. – I'd like to hear more about the barriers to achieve symbiosis.

Jennifer Howard-Grenville, Boston University – We are dealing with a lot of complexity, in terms of the level of detail of data, and inputs and outputs. One of the reasons NISP is successful is that it has a huge net of what counts included in captured synergies and NISP personnel are sharing expertise. I am not convinced that we can build a database that would make innovation, and something else is going on in functioning IS areas, so there is a lot of heterogeneity within systems.

Stephen Levine, Tufts University –Symbiosis creates positive feedback loops, which has the tendency to make systems unstable, something that tends to cause collapse.

Albena Bossilkov, Curtin University– Along the idea of collapsing systems, we have another potential example of dying. In Gladstone, 22 synergies were identified but none were taken up by companies. There was no ownership so the researcher is wrapping it up. We should try to understand the reasons for not moving forward.

Marian Chertow, Yale– Another pursuit is IE in developing countries: to what extent do we need to adapt tools generated in the West for developing countries, or vice versa? Other topics: Input Output for IS? Reverse logistics around product take-back? EIA process – incorporating what could be done with byproducts? Climate change and IS? ISIE was approached by a group from the Netherlands that wants to create an agricultural-byproducts exchange association. Is the new frontier agricultural?

Abhishek Agarwal, Gordon University– I interviewed regional coordinators in NISP and found they are neglecting SMEs and rural areas, they are not bothering because they can't reach deliverables with these guys. How can small quantities be integrated into IS aspects and work around the fixed targets in NISP?

Ines Costa, Instituto Superior Tecnico– We have talked about business and the private sector. What about the public sector, what is its role in pushing IS? What about legislation in reporting materials?

Location

Abhishek Agarwal, Gordon University- It is hard to travel somewhere for a day-long meeting, especially for us PhD students who have to find money - we should link our meeting to other conferences. There is the sustainable development conference in New Delhi in November 2008, which has about 400 people attend and has an IE session, there's lots of related stuff.

Jorgen Christensen, Kalundborg volunteered Rotterdam as an alternative site for a meeting.

Julian Cleary, University of Toronto– Regarding location, does New Hampshire have any IS or related environmental initiatives? What about Devens?

Anthony Chiu, De La Salle University– Devens with Peter or India with Ramesh. For IS we need to see a network of firms, not just one.

A Planning Committee was struck to investigate options for next year:
If Devens: Peter Lowitt, Stephen Levine , Anthony Chiu
If India: Abhishek Agarwal, Ramesh Ramaswamy, Anthony Chiu

Evaluation

Marian Chertow, Yale– Are we differentiated from ISIE?, are we practicing what we preach?

Anthony Chiu, De La Salle University– It is good to have one day discussion before ISIE.

Gemma Cervantes, Universitat Politecnica de Catalunya– It was good to have a short explanation of different projects, and it would be nice if everyone could give a 2-minute summary of their projects. In addition it would be helpful if every IS symposium could be accompanied by visits to project sites, it would be nice to see more in practice. The fee was a good idea to offset costs for the hosts. One day is good to see everyone and talk and exchange info, it would be good to have more hours in day, breakout opportunities, the connections are important.

Qingzhong Wu, Dow Chemical Co. – I was impressed by the discussion; it could be more valuable if diverse researchers and industry representatives can be brought into the discussion such as the BCSD, and others from EPA's byproduct summit.

Ray Cote, Dalhousie University- I believe the key to the success of IS symposia is that they provide an opportunity for more comprehensive discussion. This isn't available in a conference format and venue.

Appendix 1. Industrial Symbiosis Research Symposium Participants

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Appendix 2. Symposium team

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